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Climate of Nebraska

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CLIMATE OF NEBRASKA

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to

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Synopsis

The climate of Nebraska is typical of that found near the center of a large continent. It has relatively warm, sometimes hot, summers and cold winters. The summer temperatures for the past 80 years averaged 72.7 degrees. The winter temperature averaged 25.7 degrees F.

Precipitation is moderate. The annual average was 22.53 inches during the same 80 years. Most of the precipitation falls as rain. The period of April through October accounted for 83% of the total. Only part of the remaining 17% falls as snow. The snow is generally light, but it is often whipped by high winds that pile it into huge drifts. Full-blown blizzards are infrequent.

The precipitation is variable, both in time and space, but when considered on a state-wide annual basis much of the uncertainty is gone. Nebraska received more than 86% of the average precipitation in 80% of the past 80 years. Nevertheless, there are some years that stray far from the average. The wettest was 35.57 inches in 1915; the driest was 14.51 in 1934.

The records reveal recurring groups of years close together, but not necessarily consecutive, when the temperature and/or precipitation depart sharply from the long-term averages. In modern times there has been no parallel to the weather conditions of the 1930s. Three of the five driest years and four of the five hottest years in Nebraska during the 20th century occurred in the 1930s.

Time series graphs for state-wide annual precipitation and temperature are included in the respective sections of this report for the purpose of

letting the user ponder the question of cycles or trends. The variation in weather conditions are large enough and irregular enough to permit various interpretations of the data. Apparently, even the famous 20-year cycle varies enough in intensity and length of interval to make it of little value as a forecasting tool.

Precipitation in Nebraska

Precipitation in Nebraska is mainly a warm season phenomenon. During the past 49 years (1931-1979), 83% of the total precipitation fell during the seven months of April through October. The average monthly temperatures range from 49° F. in April to 76° F. in July and 53° F. in October. Only 17% of the precipitation fell during the five colder months.

The prevailing wind direction during the summer is from the south and nearly all the precipitation that falls in Nebraska originates in the Gulf of Mexico and the Carribean region. This is especially true of that which falls in the central and eastern portions of the state. The currents that carry the moisture northward from the Gulf gradually turn more toward the northeast and east as they reach higher latitudes. Nebraska lies near the western edge of this flow of moisture-laden air (see Figure 1), and hence the southeastern corner receives the most benefit; further to the west and northwest, the supply becomes smaller and smaller. This distribution of the moisture is reflected in the amount of precipitation received and as is illustrated in Figure 2. In the far western portion of the state, a noticeable but undetermined amount of the precipitation comes from Pacific Ocean moisture.

Once the moist air has arrived over the state, it is necessary to have a mechanism to cause it to condense and fall before any precipitation is realized. During the late spring and summertime, the required mechanism is nearly always convection in the unstable air mass that has been heating in the lower layers as it passes over the warm ground en route from the Gulf. The resulting showers and thunderstorms are both frontal and air mass. This type

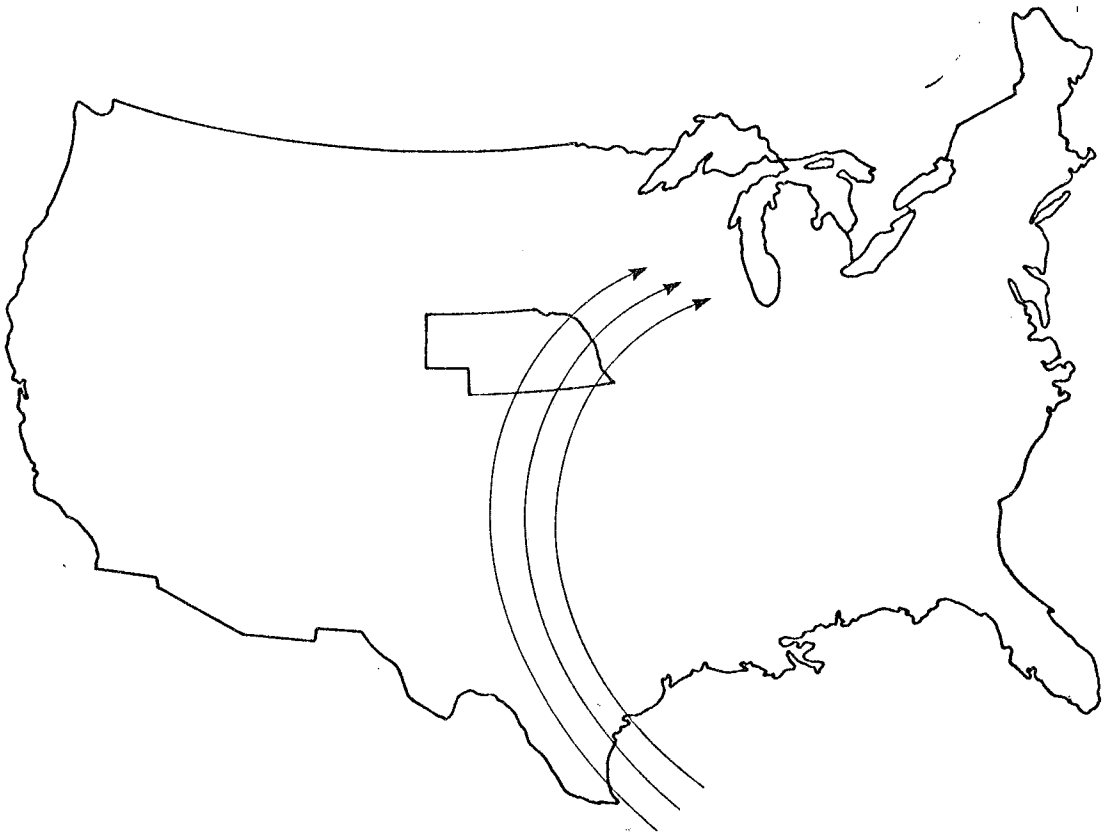

Figure 1. Flow of moisture laden air over Nebraska.

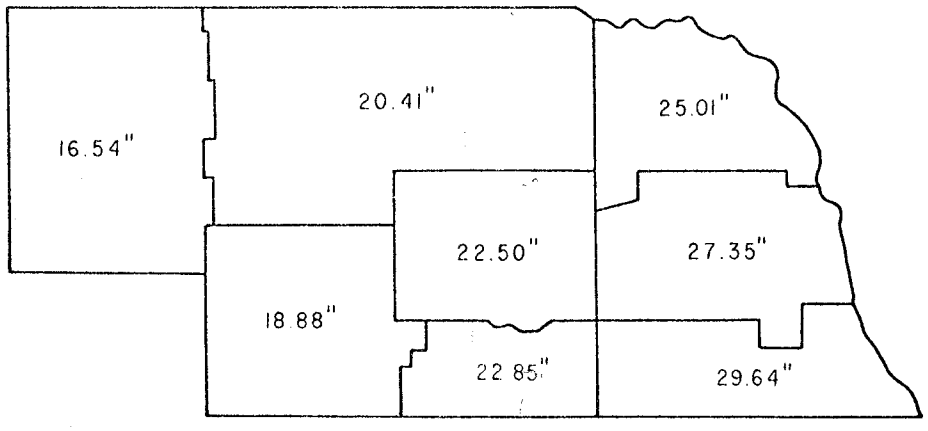

Figure 2. Average annual precipitation in inches, 1931-1979.

of action results in rainfall patterns that are highly erratic in both time and space.

Precipitation amounts from the storms vary greatly over short distances. Weekly, monthly, and even yearly totals at a site deviate widely from their long-term averages. The use of station normals* to describe the precipitation in Nebraska is strictly limited because of its erratic pattern. The frequency of various amounts is needed. It is erroneous to think that the normal amount of annual precipitation as the most likely amount that a station will receive because the normal amount seldom, if ever, occurs.

A widely used method to get a better understanding of the amount of precipitation that has fallen over a large area is to divide the area into smaller units and to find the average precipitation for each of the smaller areas. Then determine the average for the large area by weighting each smaller division according to its area in respect to the total area. This method is especially adapted to deriving the total amount of water that has been received within the boundaries of the entire area, but it does not attempt to separate the wet from the dry areas within the smallest divisions.

Historically there have been various divisions of the state--sometimes it was divided into east and west; sometimes into east, central, and west; and sometimes into other categories. The average state precipitation for Nebraska was prepared from the best information available at that time by the Section Director of the United States Weather Bureau. The results are in the NEBRASKA SECTION on CLIMATOLOGICAL DATA for the appropriate year. State averages in 1900-1930 are from this source (as shown in Table 3 on page 15). The National

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*Normal precipitation is defined as the average precipitation for the last three decades. Those currently in use are for 1941 to 1970. New ones will be computed after the close of 1980.

Climatic Center (NCC) in Asheville, North Carolina, has computed averages for the eight climatic divisions currently in use in Nebraska (see Figure 3) and also the state-wide averages. The NCC data are used for 1931 and following years.

A well-known feature of precipitation in Nebraska is its variability from time-to-time and place-to-place. Wide variations are recorded at a single site. Climatological divisional averages are somewhat less variable than those from a single site, and when statewide averages are considered, the variation drops even further. The coefficient of variation of the annual precipitation for 1931-1979 of each area--single site, division, and entire state--gives an indication of this, even though their distribution is not strictly Gaussian. The average coefficient of variation of eight stations (one from each division) is .243. The average of the eight divisions is .204, while that of the entire state is .178.

The state-wide annual precipitation is grouped heavily around the average as illustrated in Figure 4, meaning that in the majority of years a reasonable estimate of the total amount of water to be received within the state can be made. In 80% of the years from 1900 to 1979 Nebraska received more than 86% of the 80 year average of 22.53 inches. Ninety % of the years had over 78% of the average. The amounts of moisture received in the years that represent the tails of the distribution are much more varied and unpredictable. These years, although relatively few in number, are very important and are the ones that generally come to mind when weather events in Nebraska are discussed. The driest year out of the eight had only 64% of the average, or 14.51 inches. The wettest year had 158% of the average, or 35.57 inches. There is no assurance that Nebraskans will not experience both drier and wetter years. sometime in the future. Weather records are never safe from being broken. As a rule, the longer the period of record, the greater the extremes.

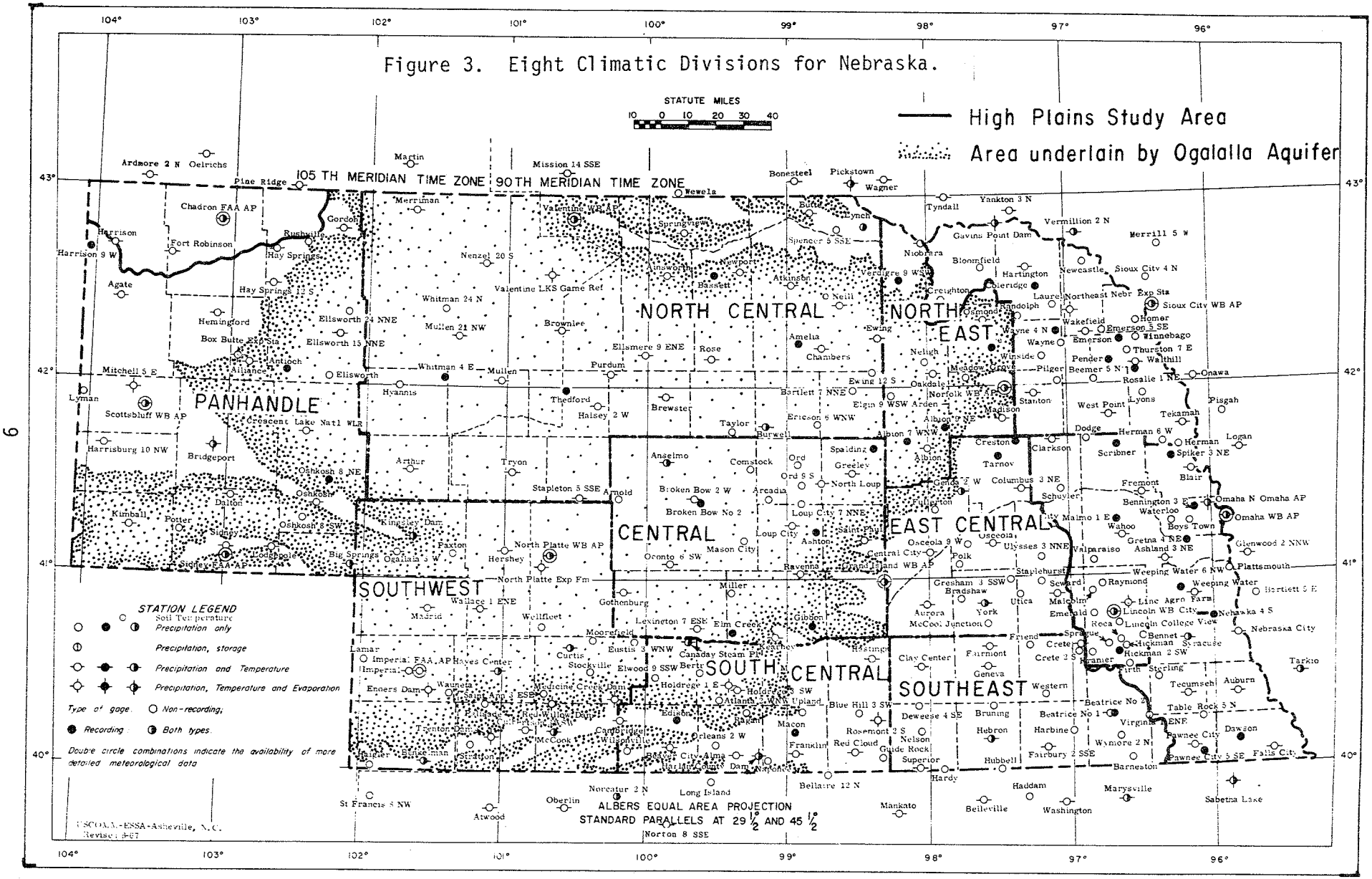


Figure 3. Eight Climatic Divisions for Nebraska.
STATUTE MILES
10 0 10 20 30 40
High Plains Study Area
Area underlain by Ogalalla Aquifer
105 TH MERIDIAN TIME ZONE
90TH MERIDIAN TIME ZONE
NORTH CENTRAL
NORTHEAST
PANHANDLE
CENTRAL
EAST CENTRAL
SOUTHWEST
SOUTH CENTRAL
SOUTHEAST
STATION LEGEND
Soil Temperature
Precipitation only
Precipitation, storage
Precipitation and Temperature
Precipitation, Temperature and Evaporation
Type of gage: Non-recording,
Recording Both types
Double circle combinations indicate the availability of more detailed meteorological data
ALBERS EQUAL AREA PROJECTION
STANDARD PARALLELS AT 29 1/2° AND 45 1/2°
USCOMM.-ESSA-Asheville, N.C.
Revised 3-67

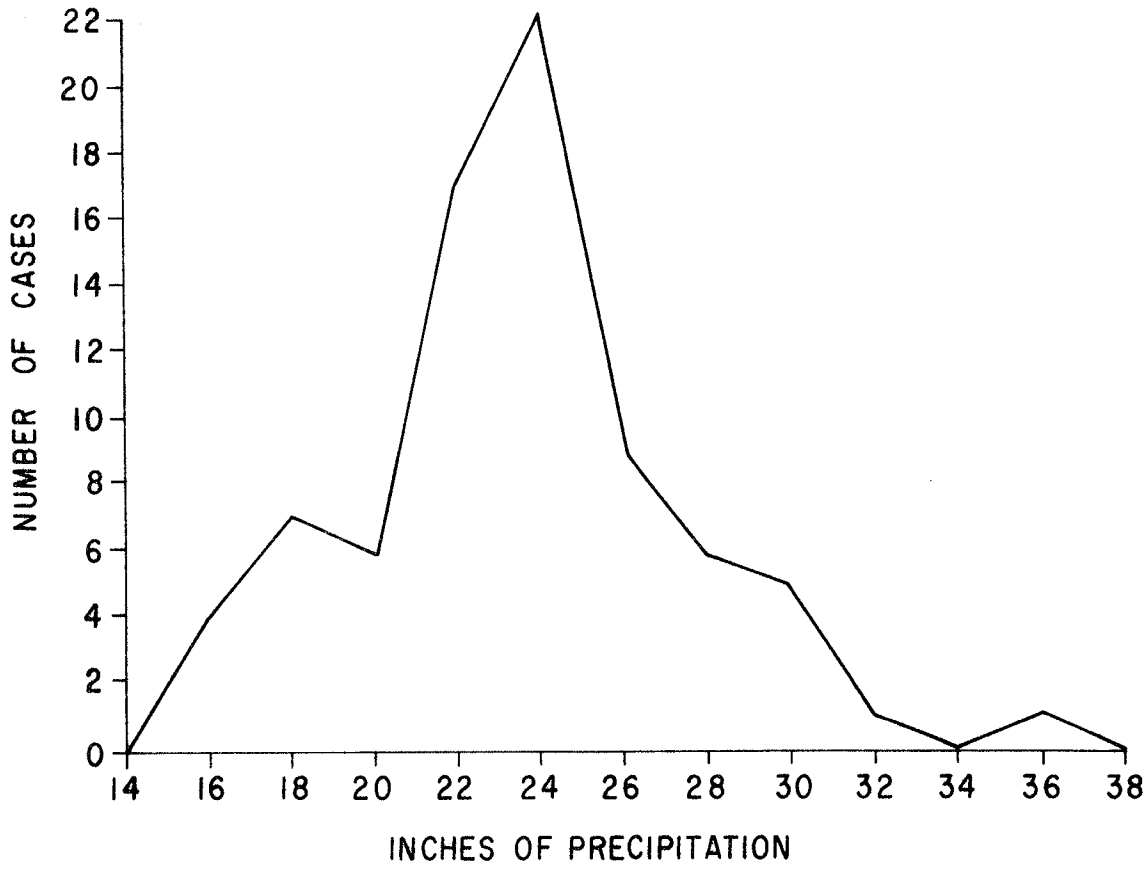


Figure 4. Annual precipitation in Nebraska expressed by cases, 1900-1979.

Table 1 contains a chronological listing of the Nebraska divisional and state precipitation amounts for the 1931-1979 period. There is no clear cut answer as to how precipitation varies from division to division within the state from year to year. There are years when some parts of the state receive amounts well above their average while others are well below theirs. All sorts of patterns emerge during most years and it is not unusual to have a wet division bordering a dry one. However, sometimes all or nearly all of the eight divisions are either wet or dry during the same year and state extremes are established during those times. Figure 5 shows the moisture distribution across the state during the two driest and the two wettest years since 1931.

It should be useful to know how often each division has received specified amounts of moisture. Table 2 has the data in Table 1 rearranged in this more useful form. The data from each division is arrayed from the least amount to the greatest. This enables the user to read off the appropriate frequency of a given amount of precipitation in any division during the past 49 years. For example, 30% of the time the southcentral division received less than about 19 1/2 inches, and an equal amount of time more than 24 3/4 inches. These figures will vary somewhat if different time periods are used in preparing the array. The same table contains two sets of values of precipitation on a statewide basis. In one array the percentages are based on 49 years, and in the other, 80 years are used. There have been two very dry periods since 1931 that are included in both arrays, while the comparative wetter period of 1900-1930 is in only one array. The results will show a higher percentage of dry years in the 49 years than in the 80 years. At the upper end of the scale the differences become less noticeable. Tables 3 and 4 are included for those interested in arrays for some other states in the Great Plains.

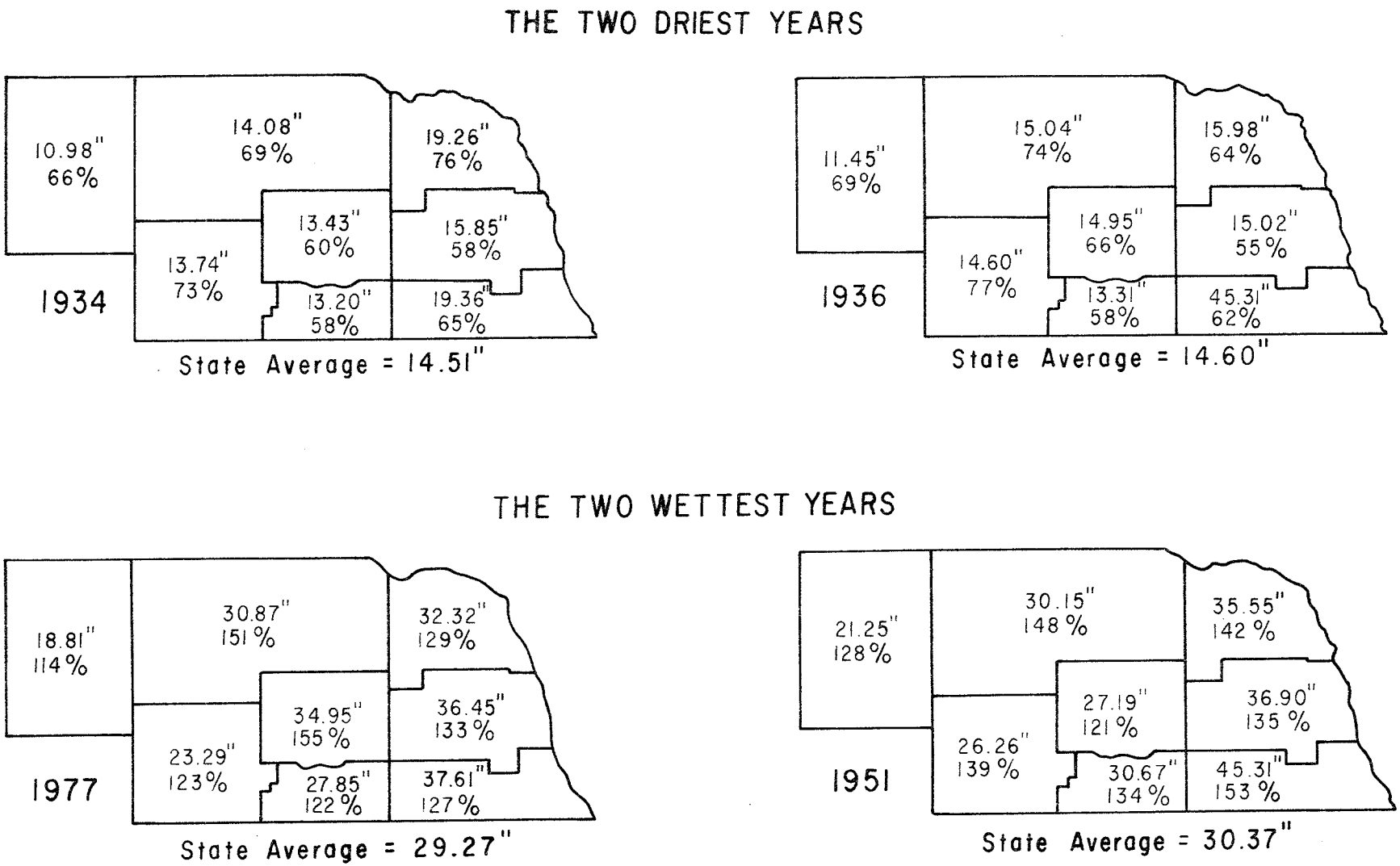
These apparent wet and dry periods of longer duration raise the question of cycles or trends in weather patterns. Seeking an answer to this question

Table 1

Annual Precipitation for Nebraska Climatic Divisions in Inches 1931-1979

	P-HNDL	N-CNTRL	N-EAST	CNTRL	E-CNTRL	S-WEST	S-CNTRL	S-EAST	STATE	
1931	11.71	15.58	21.95	18.93	31.03	16.03	21.50	33.15	19.43	1931
1932	13.76	19.48	25.58	23.74	29.18	17.22	19.20	26.41	20.80	1932
1933	16.77	18.76	20.83	21.78	22.78	20.50	20.58	23.18	20.03	1933
1934	10.98	14.05	19.26	13.43	15.85	13.74	13.20	19.36	14.51	1934
1935	16.93	20.69	23.66	23.95	27.75	22.05	22.71	31.11	22.57	1935
1936	11.45	15.04	15.98	14.95	15.02	14.60	13.31	18.42	14.60	1936
1937	12.35	16.56	22.53	20.65	21.16	16.12	18.82	21.33	17.76	1937
1938	19.70	20.85	25.34	19.91	26.69	18.39	20.90	29.74	22.10	1938
1939	12.35	17.04	17.28	16.74	18.84	14.45	16.64	21.66	16.43	1939
1940	12.92	15.15	25.88	15.14	22.40	16.70	17.36	23.92	17.67	1940
1941	20.01	22.48	26.13	23.07	26.94	22.77	28.05	35.46	24.42	1941
1942	23.30	22.72	24.62	27.78	24.96	25.06	27.85	31.59	25.10	1942
1943	13.85	17.28	18.98	18.16	21.51	12.55	16.59	25.44	17.45	1943
1944	20.20	24.77	35.37	24.75	35.53	23.41	30.31	39.74	27.61	1944
1945	18.86	19.32	27.45	21.82	32.95	19.19	21.61	31.22	22.92	1945
1946	17.76	24.47	28.51	26.28	28.50	24.93	30.34	29.52	25.09	1946
1947	20.54	20.93	25.79	23.84	30.23	19.20	22.21	29.40	23.23	1947
1948	17.35	19.44	25.24	21.37	29.36	17.90	19.59	29.41	21.58	1948
1949	19.24	24.51	26.42	24.82	29.06	22.71	26.34	36.29	25.17	1949
1950	15.44	22.41	26.61	24.92	26.14	18.88	22.85	32.48	22.66	1950
1951	21.25	30.15	35.55	27.19	36.90	26.26	30.67	45.31	30.37	1951
1952	14.91	15.85	25.92	17.71	29.45	14.60	20.71	32.52	19.91	1952
1953	17.12	21.27	24.69	21.16	21.38	16.60	21.79	22.68	20.43	1953
1954	14.30	18.73	24.54	18.71	25.44	12.33	18.43	30.91	19.48	1954
1955	17.69	15.93	17.99	17.06	18.63	14.66	17.81	19.68	17.14	1955
1956	12.00	15.14	17.55	15.25	19.41	14.31	15.80	21.32	15.75	1956
1957	20.57	25.78	28.98	29.50	33.53	23.22	29.66	33.43	26.92	1957
1958	18.26	21.45	22.75	22.34	28.37	22.09	23.74	34.68	23.20	1958
1959	15.75	19.96	30.28	23.65	34.77	18.60	23.97	34.85	23.54	1959
1960	13.75	21.55	29.07	24.91	31.28	17.41	26.14	32.62	22.96	1960
1961	17.20	19.03	22.74	23.20	28.49	18.88	25.83	36.66	22.41	1961
1962	18.98	28.00	27.71	28.58	28.35	26.12	27.01	29.69	26.26	1962
1963	16.96	20.90	23.25	20.48	24.46	18.68	20.63	27.30	21.02	1963
1964	11.46	19.17	27.12	21.17	30.16	15.39	18.75	26.87	20.11	1964
1965	21.67	24.01	31.64	31.45	39.98	27.03	36.04	35.92	28.99	1965
1966	16.16	18.53	22.75	19.50	21.59	18.57	17.49	20.42	19.04	1966
1967	18.99	18.73	23.22	23.56	29.84	18.73	24.12	29.90	22.18	1967
1968	16.92	21.06	25.26	23.86	31.38	15.39	24.08	30.60	22.42	1968
1969	15.63	17.98	25.51	24.18	26.94	20.14	29.18	33.09	22.10	1969
1970	14.79	17.62	23.75	19.36	25.60	14.08	19.81	28.08	19.37	1970
1971	18.40	23.83	25.96	24.63	27.55	23.28	24.68	27.24	23.80	1971
1972	17.18	21.86	29.81	23.20	32.47	18.66	24.46	29.95	23.61	1972
1973	20.45	25.46	30.42	30.75	38.95	24.22	32.65	46.43	29.10	1973
1974	11.88	14.79	18.10	16.49	20.54	14.69	15.67	18.88	15.77	1974
1975	14.09	17.42	24.62	23.09	24.85	18.69	24.36	28.16	20.37	1975
1976	13.27	16.69	16.52	20.91	19.07	15.72	17.99	23.25	17.23	1976
1977	18.81	30.87	32.32	34.95	36.45	23.29	27.85	37.61	29.27	1977
1978	18.26	22.01	23.43	23.58	29.04	15.17	21.02	33.11	22.45	1978
1979	18.25	25.02	30.53	25.98	29.62	22.04	29.36	32.58	25.46	1979
Avg.	16.54	20.41	25.01	22.50	27.35	18.88	22.85	29.64	21.87	
Std Dev	3.14	3.95	4.55	4.48	5.79	3.94	5.19	6.39	3.89	
Coef Vtn.	.190	.194	.182	.199	.212	.209	.227	.215	.178	

Source: National Climatic Center, Ashville, N.C.



Upper figure - Amount of precipitation - Inches
Lower figure - % of 49 year average

Figure 5. Precipitation for Nebraska's two driest and two wettest years --1931-1979

Table 2

Forty Nine Year Annual Precipitation Array for Nebraska Climatic Divisions in Inches

	P-HNDL	N-CNTRL	N-EAST	CNTRL	E-CNTRL	S-WEST	S-CNTRL	S-EAST	STATE	STATE 80 year array
1	10.98	14.05	15.98	13.43	15.02	12.33	13.20	18.42	14.51	
2	11.45	14.79	16.52	14.95	15.85	12.55	13.31	18.88	14.60	
3	11.46	15.04	17.28	15.14	18.63	13.74	15.67	19.36	15.75	
4	11.71	15.14	17.55	15.25	18.84	14.08	15.80	19.68	15.77	
4.9 = 10% of years										10% 17.23*
5	11.88	15.15	17.99	16.49	19.07	14.31	16.59	20.42	16.43	
6	12.00	15.58	18.10	16.74	19.41	14.45	16.64	21.32	17.14	
7	12.35	15.83	18.98	17.06	20.54	14.60	17.36	21.33	17.23	
8	12.35	15.93	19.26	17.71	21.16	14.60	17.49	21.66	17.45	
9	12.92	16.56	20.83	18.16	21.38	14.66	17.81	22.68	17.67	
9.8 = 20% of the years										20% 19.48
10	13.27	16.69	21.95	18.71	21.51	14.69	17.99	23.18	17.76	
11	13.75	17.04	22.53	18.93	21.59	15.17	18.43	23.25	19.04	
12	13.76	17.28	22.74	19.36	22.40	15.39	18.75	23.92	19.37	
13	13.85	17.42	22.75	19.50	22.78	15.39	18.82	25.44	19.43	
14	14.09	17.62	22.75	19.91	24.46	15.72	19.20	26.41	19.48	
14.7 = 30% of the years										30% 20.49
15	14.30	17.98	23.22	20.48	24.85	16.03	19.59	26.87	19.91	
16	14.79	18.53	23.25	20.65	24.96	16.12	19.81	27.24	20.03	
17	14.91	18.73	23.43	20.91	25.44	16.60	20.58	27.30	20.11	
18	15.44	18.73	23.66	21.16	25.60	16.70	20.63	28.08	20.37	
19	15.63	18.76	23.95	21.17	26.14	17.22	20.71	28.16	20.43	
19.6 = 40% of the years										40% 21.20
20	15.75	19.03	24.54	21.37	26.69	17.41	20.90	29.40	20.80	
21	16.16	19.17	24.62	21.78	26.94	17.90	21.02	29.41	21.02	
22	16.77	19.32	24.62	21.82	26.94	18.39	21.50	29.52	21.58	
23	16.92	19.44	24.69	22.34	27.55	18.57	21.61	29.69	22.10	
24	16.93	19.48	25.24	23.07	27.75	18.60	21.79	29.74	22.10	
24.5 = 50% Of the years										50% 22.41
25	16.96	19.96	25.26	23.09	28.35	18.66	22.21	29.90	22.18	
26	17.12	20.69	25.34	23.20	28.37	18.68	22.71	29.95	22.41	
27	17.18	20.85	25.51	23.20	28.49	18.69	22.85	30.60	22.42	
28	17.20	20.90	25.58	23.56	28.50	18.73	23.74	30.91	22.45	
29	17.35	20.93	25.79	23.58	29.04	18.88	23.97	31.11	22.57	
29.4 = 60% of the years										60%22.96
30	17.69	21.06	25.88	23.65	29.06	18.88	24.08	31.22	22.66	
31	17.76	21.27	25.92	23.74	29.18	19.19	24.12	31.59	22.92	
32	18.25	21.45	25.96	23.84	29.36	19.20	24.36	32.48	22.96	
33	18.26	21.55	26.13	23.86	29.45	20.14	24.46	32.52	23.20	
34	18.26	21.86	26.42	23.95	29.62	20.50	24.68	32.58	23.23	
34.3 = 70% of the years										70% 23.80
35	18.40	22.01	26.61	24.18	29.84	22.04	25.83	32.62	23.54	
36	18.81	22.41	27.12	24.63	30.16	22.05	26.14	33.09	23.61	
37	18.86	22.48	27.45	24.75	30.23	22.09	26.34	33.11	23.80	
38	18.98	22.72	27.71	24.82	31.03	22.71	27.01	33.15	24.42	
39	18.99	23.83	28.51	24.91	31.28	22.77	27.85	33.43	25.09	
39.2 = 80% of the years										80% 25.17
40	19.24	24.01	28.98	24.92	31.38	23.22	27.85	34.68	25.10	
41	19.70	24.47	29.07	25.98	32.47	23.28	28.05	34.85	25.17	
42	20.01	24.51	29.81	26.28	32.95	23.29	29.18	35.46	25.46	
43	20.20	24.77	30.28	27.19	33.53	23.41	29.36	35.92	26.26	
44	20.45	25.02	30.42	27.78	34.77	24.22	29.66	36.29	26.92	
44.1 = 90% of the years										90% 27.61
45	20.54	25.46	30.53	28.58	35.53	24.93	30.31	36.66	27.61	
46	20.57	25.78	31.64	29.50	36.45	25.06	30.34	37.61	28.90	
47	21.25	28.00	32.32	30.75	36.90	26.12	30.67	39.74	29.10	
48	21.67	30.15	35.37	31.45	38.95	26.26	32.65	45.31	29.27	
49	23.30	30.87	35.55	34.95	39.98	27.03	36.04	46.43	30.37	

Table 3
(Page 1 of 2)

Annual Precipitation for Great Plains States in Inches[1]
1900-1979

DATE	COLO.	KAN.	MONT.	NEBR.	N.MEX.	N.DAK.	OKLA.	S.DAK.	TEXAS	WYO.
1900[2]	14.43	27.96	14.38	23.92	13.52	19.06	32.51	19.97	42.17	10.95
1901	14.14	21.35	15.36	23.02	14.50	19.41	22.78	21.23	22.23	12.14
1902	13.88	34.42	15.12	29.47	9.97	19.35	40.54	19.54	33.92	9.81
1903	13.80	31.35	15.54	26.66	11.25	19.24	29.41	21.05	33.03	12.87
1904	16.30	31.01	11.42	23.53	14.41	17.81	29.79	16.61	30.02	14.29
1905	18.09	30.77	13.69	31.53	20.95	18.91	39.76	24.66	41.73	16.03
1906	19.71	28.58	18.59	26.04	15.89	20.03	36.88	24.62	31.51	17.82
1907	16.33	26.46	17.87	20.13	16.13	14.31	33.85	18.70	33.86	14.63
1908	17.09	32.30	19.26	26.48	12.68	18.55	47.73	22.62	32.91	17.28
1909	20.96	31.15	19.72	24.64	12.83	18.10	27.01	22.74	23.45	16.33
1910	14.35	19.67	16.09	16.67	9.46	12.54	18.92	15.03	21.46	12.12
1911	19.24	24.53	17.94	21.20	17.92	18.42	28.93	18.26	29.13	13.98
1912	18.84	26.69	17.44	21.45	13.92	20.39	28.40	18.02	26.12	18.40
1913	17.78	23.02	15.51	21.89	15.36	14.65	33.06	17.49	36.05	15.88
1914	19.26	23.08	15.73	20.71	19.45	18.97	25.97	21.36	37.88	12.69
1915	19.44	40.77	19.03	35.57	17.64	19.28	45.52	28.61	32.01	19.42
1916	18.70	23.84	18.92	18.83	15.95	19.87	29.18	20.66	24.59	12.70
1917	14.74	19.60	14.80	20.53	9.49	10.75	22.39	16.66	16.21	13.75
1918	18.75	27.60	14.19	22.36	15.08	16.01	33.56	21.52	28.90	16.05
1919	17.14	25.65	10.88	25.09	20.95	15.59	34.41	19.64	45.64	10.46
1920	17.75	26.65	14.59	24.47	14.87	15.28	36.35	23.41	34.24	14.88
1921	19.37	24.19	14.64	20.49	16.46	19.44	30.02	18.87	28.64	12.58
1922	15.60	29.01	15.75	20.15	10.86	19.89	33.89	21.44	32.91	14.16
1923	21.23	31.88	18.14	28.18	19.46	17.79	44.98	21.98	40.34	19.31
1924	13.75	24.23	13.70	20.89	10.65	17.12	27.86	17.92	23.50	12.69
1925	16.96	25.08	16.05	20.78	13.86	16.65	28.31	15.76	25.79	15.62
1926	16.98	24.80	14.05	20.83	17.44	15.37	39.04	17.36	36.33	14.58
1927	20.32	32.40	21.12	23.67	13.94	21.51	39.55	23.13	27.77	18.16
1928	17.05	33.40	13.17	22.80	15.09	17.88	36.48	17.42	29.03	14.23
1929	18.16	27.96	13.08	22.74	16.48	14.31	35.39	20.63	31.17	15.06
1930	17.32	26.87	12.76	25.94	14.64	14.89	30.70	17.83	29.67	14.70
1931[3]	12.67	25.86	9.97	19.43	17.90	15.51	31.79	14.32	27.43	11.07
1932	13.25	23.56	16.03	20.80	15.25	17.14	34.31	18.28	32.68	12.71
1933	14.40	21.65	15.01	20.03	12.43	13.52	30.51	14.73	23.11	11.62
1934	10.38	19.72	10.72	14.51	9.45	9.78	26.89	12.55	23.04	10.63
1935	14.80	27.60	11.14	22.57	13.96	18.12	37.50	16.44	34.57	11.70
1936	15.32	18.45	10.96	14.60	12.56	8.65	22.70	10.89	28.57	13.01
1937	13.80	20.68	12.62	17.76	13.38	17.62	28.87	17.31	25.16	15.04
1938	18.48	26.90	16.49	22.10	13.41	15.22	33.53	17.56	24.98	14.43
1939	10.42	19.81	12.56	16.43	12.33	14.25	26.63	15.61	23.25	9.81

1. Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Wyoming (High Plains States are underlined)
2. 1900-1930 data from Climatological Data
3. 1931-1979 data from NOAA, National Climatic Center

Table 3
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Annual Precipitation for Great Plains States in Inches 1900-1979

DATE	COLO.	KAN.	MONT.	NEBR.	N.MEX.	N.DAK.	OKLA.	S.DAK.	TEXAS	WYO.
1940	16.02	24.76	15.19	17.67	14.42	17.35	33.43	15.67	32.09	13.58
1941	21.94	36.41	17.33	24.42	27.07	23.30	46.50	21.46	40.93	17.15
1942	18.26	32.37	16.09	25.10	14.47	18.83	39.98	23.80	30.34	14.52
1943	14.22	24.13	14.77	17.45	11.17	18.38	28.92	17.28	22.42	12.04
1944	16.18	36.49	15.69	27.61	13.84	21.55	36.56	24.64	33.39	14.92
1945	16.39	29.31	14.20	22.92	9.29	14.95	42.28	17.21	29.39	16.54
1946	16.44	28.10	16.69	25.09	12.83	17.17	35.83	24.62	33.25	14.52
1947	17.67	26.87	15.13	23.23	10.29	18.39	31.06	17.80	23.72	15.97
1948	14.83	29.25	16.28	21.58	12.03	17.52	31.90	19.40	20.70	12.32
1949	16.75	32.39	12.33	25.17	15.13	16.67	38.87	17.17	34.09	13.41
1950	12.32	26.63	15.93	22.66	10.30	18.32	35.28	17.85	25.01	13.08
1951	16.50	41.49	16.53	30.37	9.71	16.87	35.24	22.19	20.76	13.42
1952	13.41	18.68	10.72	19.91	11.02	12.35	23.86	13.90	22.41	10.56
1953	14.03	20.88	16.19	20.43	9.31	19.98	31.68	21.83	23.63	11.19
1954	11.66	20.03	14.75	19.48	10.96	18.62	22.93	17.28	18.01	9.27
1955	13.39	22.18	15.96	17.14	10.99	17.13	29.38	15.92	22.74	12.60
1956	11.19	15.41	12.41	15.75	6.55	17.42	21.21	16.87	15.53	9.59
1957	21.35	33.79	15.31	26.92	15.91	18.72	48.23	22.48	36.93	15.18
1958	14.31	32.15	15.02	23.20	16.40	13.64	33.12	14.91	30.77	11.31
1959	15.67	28.79	14.90	23.54	12.89	15.91	40.33	16.79	30.33	10.98
1960	13.53	27.61	10.69	22.96	14.53	14.83	36.21	18.50	31.92	9.10
1961	17.38	34.95	13.36	22.41	13.44	13.17	38.09	16.11	28.90	11.69
1962	12.58	28.00	16.50	26.26	12.27	20.79	32.65	24.87	24.33	12.86
1963	13.44	20.88	14.99	21.02	11.08	17.39	21.73	19.87	19.74	13.04
1964	13.04	24.61	17.63	20.11	9.97	19.34	33.14	17.90	23.74	12.77
1965	20.05	32.12	16.93	28.90	15.01	21.17	29.93	21.39	26.83	13.68
1966	12.38	17.60	13.25	19.04	11.69	16.69	25.24	18.59	26.91	10.17
1967	16.52	29.53	16.16	22.18	12.88	14.22	32.52	17.45	25.48	15.34
1968	13.23	27.37	16.61	22.42	12.28	18.98	39.42	21.00	33.20	13.41
1969	19.29	30.82	14.57	22.10	15.96	16.64	33.62	17.61	29.82	11.21
1970	15.07	24.02	16.67	19.37	10.31	18.84	29.33	18.63	23.88	13.06
1971	14.58	28.09	14.97	23.80	13.28	19.52	34.20	21.17	28.39	14.43
1972	15.11	28.05	15.63	23.61	16.57	17.38	29.79	17.86	27.06	13.30
1973	16.20	40.29	14.02	29.10	11.79	16.36	47.07	19.03	35.45	14.78
1974	12.40	24.65	14.97	15.77	14.52	15.68	39.37	12.99	32.28	9.90
1975	14.11	26.29	20.66	20.37	12.69	20.85	35.92	18.55	27.30	13.04
1976	12.75	21.24	14.09	17.23	11.01	12.12	26.75	12.88	30.70	11.64
1977	13.57	32.74	15.26	29.27	12.74	21.36	32.25	25.37	22.76	12.48
1978	14.72	24.12	19.34	22.45	16.15	17.62	28.49	19.29	25.87	14.73
1979	16.93	29.70	10.91	25.46	14.20	14.48	35.14	18.47	31.43	10.24
Avg.	15.88	27.17	15.16	22.53	13.73	17.15	33.04	18.99	28.84	13.46
Std Dev	2.69	5.39	2.41	3.96	3.20	2.78	6.42	3.33	6.02	2.35
Coef Vtn.	.169	.198	.159	.176	.233	.162	.194	.175	.209	.175

Table 4
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Eighty Year Annual Precipitation Array for Great Plains States in Inches[1]

	Colorado	Kansas	Montana	Nebraska	N. Mexico	
1	10.38-1934	15.41-1956	9.97-1931	14.51-1934	6.55-1956	1
2	10.42-1939	17.60-1966	10.69-1960	14.60-1936	9.29-1945	2
3	11.19-1956	18.45-1936	10.72-1934	15.75-1956	9.31-1953	3
4	11.66-1954	18.68-1952	10.72-1952	15.77-1974	9.45-1934	4
5	12.32-1950	19.60-1917	10.88-1919	16.43-1939	9.46-1910	5
6	12.38-1966	19.67-1910	10.91-1979	16.67-1910	9.49-1917	6
7	12.40-1974	19.72-1934	10.96-1936	17.14-1955	9.71-1951	7
8 10%	12.58-1962	19.81-1939	11.14-1935	17.23-1976	9.97-1902 10%	8
9	12.67-1931	20.03-1954	11.42-1904	17.45-1943	9.97-1964	9
10	12.75-1976	20.68-1937	12.33-1949	17.67-1940	10.29-1947	10
11	13.04-1964	20.88-1953	12.41-1956	17.76-1937	10.30-1950	11
12	13.23-1968	20.88-1963	12.56-1939	18.83-1916	10.31-1970	12
13	13.25-1932	21.24-1976	12.62-1937	19.04-1966	10.65-1924	13
14	13.39-1955	21.35-1901	12.76-1930	19.37-1970	10.86-1922	14
15	13.41-1952	21.65-1933	13.08-1929	19.43-1931	10.96-1954	15
16 20%	13.44-1963	22.18-1955	13.17-1928	19.48-1954	10.99-1955 20%	16
17	13.53-1960	23.02-1913	13.25-1966	19.91-1952	11.01-1976	17
18	13.57-1977	23.08-1914	13.36-1961	20.03-1933	11.02-1952	18
19	13.75-1924	23.56-1932	13.69-1905	20.11-1964	11.08-1963	19
20	13.80-1903	23.84-1916	13.70-1924	20.13-1907	11.17-1943	20
21	13.80-1937	24.02-1970	14.02-1973	20.15-1922	11.25-1903	21
22	13.88-1902	24.12-1978	14.05-1926	20.37-1975	11.69-1966	22
23	14.03-1953	24.13-1943	14.09-1976	20.43-1953	11.79-1973	23
24 30%	14.11-1975	24.19-1921	14.19-1918	20.49-1921	12.03-1948 30%	24
25	14.14-1901	24.23-1924	14.20-1945	20.53-1917	12.27-1962	25
26	14.22-1943	24.53-1911	14.38-1900	20.71-1914	12.28-1968	26
27	14.31-1958	24.61-1964	14.57-1969	20.78-1925	12.33-1939	27
28	14.35-1910	24.65-1974	14.59-1920	20.80-1932	12.43-1933	28
29	14.40-1933	24.76-1940	14.64-1921	20.83-1926	12.56-1936	29
30	14.43-1900	24.80-1926	14.75-1954	20.89-1924	12.68-1908	30
31	14.58-1971	25.08-1925	14.77-1943	21.02-1963	12.69-1975	31
32 40%	14.72-1978	25.65-1919	14.80-1917	21.20-1911	12.74-1977 40%	32
33	14.74-1917	25.86-1931	14.90-1959	21.45-1912	12.83-1909	33
34	14.80-1935	26.29-1975	14.97-1971	21.58-1948	12.83-1946	34
35	14.83-1948	26.46-1907	14.97-1974	21.89-1913	12.88-1967	35
36	15.07-1970	26.63-1950	14.99-1963	22.10-1938	12.89-1959	36
37	15.11-1972	26.65-1920	15.01-1933	22.10-1969	13.28-1971	37
38	15.32-1936	26.69-1912	15.02-1958	22.18-1967	13.38-1937	38
39	15.60-1922	26.87-1930	15.12-1902	22.36-1918	13.41-1938	39
40 50%	15.67-1959	26.87-1947	15.13-1947	22.41-1961	13.44-1961 50%	40

1. Colorado, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Wyoming (High Plains States are underlined)

Table 4
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Eighty Year Annual Precipitation Array for Great Plains States in Inches

		Colorado	Kansas	Montana	Nebraska	N. Mexico		
41		16.02-1940	26.90-1938	15.19-1940	22.42-1968	13.52-1900		41
42		16.18-1944	27.37-1968	15.26-1977	22.45-1978	13.84-1944		42
43		16.20-1973	27.60-1918	15.31-1957	22.57-1935	13.86-1925		43
44		16.30-1904	27.60-1935	15.36-1901	22.66-1950	13.92-1912		44
45		16.33-1907	27.61-1960	15.51-1913	22.74-1929	13.94-1927		45
46		16.39-1945	27.96-1900	15.54-1903	22.80-1928	13.96-1935		46
47		16.44-1946	27.96-1929	15.63-1972	22.92-1945	14.20-1979		47
48	60%	16.50-1951	28.00-1962	15.69-1944	22.96-1960	14.41-1904	60%	48
49		16.52-1967	28.05-1972	15.73-1914	23.02-1901	14.42-1940		49
50		16.75-1949	28.09-1971	15.75-1922	23.20-1958	14.47-1942		50
51		16.93-1979	28.10-1946	15.93-1950	23.23-1947	14.50-1901		51
52		16.96-1925	28.58-1906	15.96-1955	23.53-1904	14.52-1974		52
53		16.98-1926	28.79-1959	16.03-1932	23.54-1959	14.53-1960		53
54		17.05-1928	29.01-1922	16.05-1925	23.61-1972	14.64-1930		54
55		17.09-1908	29.25-1948	16.09-1910	23.67-1927	14.87-1920		55
56	70%	17.14-1919	29.31-1945	16.09-1942	23.80-1971	15.01-1965	70%	56
57		17.32-1930	29.53-1967	16.16-1967	23.92-1900	15.08-1918		57
58		17.38-1961	29.70-1979	16.19-1953	24.42-1941	15.09-1928		58
59		17.67-1947	30.77-1905	16.28-1948	24.47-1920	15.13-1949		59
60		17.75-1920	30.82-1969	16.49-1938	24.64-1909	15.25-1932		60
61		17.78-1913	31.01-1904	16.50-1962	25.09-1919	15.36-1913		61
62		18.09-1905	31.15-1909	16.53-1951	25.09-1946	15.89-1906		62
63		18.16-1929	31.35-1903	16.61-1968	25.10-1942	15.91-1957		63
64	80%	18.26-1942	31.88-1923	16.67-1970	25.17-1949	15.95-1916	80%	64
65		18.48-1938	32.12-1965	16.69-1946	25.46-1979	15.96-1969		65
66		18.70-1916	32.15-1958	16.93-1965	25.94-1930	16.13-1907		66
67		18.75-1918	32.30-1908	17.33-1941	26.04-1906	16.15-1978		67
68		18.84-1912	32.37-1942	17.44-1912	26.26-1962	16.40-1958		68
69		19.24-1911	32.39-1949	17.63-1964	26.48-1908	16.46-1921		69
70		19.26-1914	32.40-1927	17.87-1907	26.66-1903	16.48-1929		70
71		19.29-1969	32.74-1977	17.94-1911	26.92-1957	16.57-1972		71
72	90%	19.37-1921	33.40-1928	18.14-1923	27.61-1944	17.44-1926	90%	72
73		19.44-1915	33.79-1957	18.59-1906	28.18-1923	17.64-1915		73
74		19.71-1906	34.42-1902	18.92-1916	28.90-1965	17.90-1931		74
75		20.05-1965	34.95-1961	19.03-1915	29.10-1973	17.92-1911		75
76		20.32-1927	36.41-1941	19.26-1908	29.27-1977	19.45-1914		76
77		20.96-1909	36.49-1944	19.34-1978	29.47-1902	19.46-1923		77
78		21.23-1923	40.29-1973	19.72-1909	30.37-1951	20.95-1905		78
79		21.35-1957	40.77-1915	20.66-1975	31.53-1905	20.95-1919		79
80		21.94-1941	41.49-1951	21.12-1927	35.57-1915	27.07-1941		80

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Eighty Year Annual Precipitation Array for Great Plains States in Inches

		N. DAKOTA	OKLAHOMA	S. DAKOTA	TEXAS	WYOMING		
1		8.65-1936	18.92-1910	10.89-1936	15.53-1956	9.10-1960		1
2		9.78-1934	21.21-1956	12.55-1934	16.21-1917	9.27-1954		2
3		10.75-1917	21.73-1963	12.88-1976	18.01-1954	9.59-1956		3
4		12.12-1976	22.39-1917	12.99-1974	19.74-1963	9.81-1902		4
5		12.35-1952	22.70-1936	13.90-1952	20.70-1948	9.81-1939		5
6		12.54-1910	22.78-1901	14.32-1931	20.76-1951	9.90-1974		6
7		13.17-1961	22.93-1954	14.73-1933	21.46-1910	10.17-1966		7
8	10%	13.52-1933	23.86-1952	14.91-1958	22.23-1901	10.24-1979	10%	8
9		13.64-1958	25.24-1966	15.03-1910	22.41-1952	10.46-1919		9
10		14.22-1967	25.97-1914	15.61-1939	22.42-1943	10.56-1952		10
11		14.25-1939	26.63-1939	15.67-1940	22.74-1955	10.63-1934		11
12		14.31-1907	26.75-1976	15.76-1925	22.76-1977	10.95-1900		12
13		14.31-1929	26.89-1934	15.92-1955	23.04-1934	10.98-1959		13
14		14.48-1979	27.01-1909	16.11-1961	23.11-1933	11.07-1931		14
15		14.65-1913	27.86-1924	16.44-1935	23.25-1939	11.19-1953		15
16	20%	14.83-1960	28.31-1925	16.61-1904	23.45-1909	11.21-1969	20%	16
17		14.89-1930	28.40-1912	16.66-1917	23.50-1924	11.31-1958		17
18		14.95-1945	28.49-1978	16.79-1959	23.63-1953	11.62-1933		18
19		15.22-1938	28.87-1937	16.87-1956	23.72-1947	11.64-1976		19
20		15.28-1920	28.92-1943	17.17-1949	23.74-1964	11.69-1961		20
21		15.37-1926	28.93-1911	17.21-1945	23.88-1970	11.70-1935		21
22		15.51-1931	29.18-1916	17.28-1943	24.33-1962	12.04-1943		22
23		15.59-1919	29.33-1970	17.28-1954	24.59-1916	12.12-1910		23
24	30%	15.68-1974	29.38-1955	17.31-1937	24.98-1938	12.14-1901	30%	24
25		15.91-1959	29.41-1903	17.36-1926	25.01-1950	12.32-1948		25
26		16.01-1918	29.79-1904	17.42-1928	25.16-1937	12.48-1977		26
27		16.36-1973	29.79-1972	17.45-1967	25.48-1967	12.58-1921		27
28		16.64-1969	29.93-1965	17.49-1913	25.79-1925	12.60-1955		28
29		16.65-1925	30.02-1921	17.56-1938	25.87-1978	12.69-1914		29
30		16.67-1949	30.51-1933	17.61-1969	26.12-1912	12.69-1924		30
31		16.69-1966	30.70-1930	17.80-1947	26.83-1965	12.70-1916		31
32	40%	16.87-1951	31.06-1947	17.83-1930	26.91-1966	12.71-1932	40%	32
33		17.12-1924	31.68-1953	17.85-1950	27.06-1972	12.77-1964		33
34		17.13-1955	31.79-1931	17.86-1972	27.30-1975	12.86-1962		34
35		17.14-1932	31.90-1948	17.90-1964	27.43-1931	12.87-1903		35
36		17.17-1946	32.25-1977	17.92-1924	27.77-1927	13.01-1936		36
37		17.35-1940	32.51-1900	18.02-1912	28.39-1971	13.04-1963		37
38		17.38-1972	32.52-1967	18.26-1911	28.57-1936	13.04-1975		38
39		17.39-1963	32.65-1962	18.28-1932	28.64-1921	13.06-1970		39
40	50%	17.42-1956	33.06-1913	18.47-1979	28.90-1918	13.08-1950	50%	40

Table 4
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Eighty Year Annual Precipitation Array for Great Plains States in Inches

		N. DAKOTA	OKLAHOMA	S. DAKOTA	TEXAS	WYOMING		
41		17.52-1948	33.12-1958	18.50-1960	28.90-1961	13.30-1972		41
42		17.62-1937	33.14-1964	18.55-1975	29.03-1928	13.41-1949		42
43		17.62-1978	33.43-1940	18.59-1966	29.13-1911	13.41-1968		43
44		17.79-1923	33.53-1938	18.63-1970	29.39-1945	13.42-1951		44
45		17.81-1904	33.56-1918	18.70-1907	29.67-1930	13.58-1940		45
46		17.88-1928	33.62-1969	18.87-1921	29.82-1969	13.68-1965		46
47		18.10-1909	33.85-1907	19.03-1973	30.02-1904	13.75-1917		47
48	60%	18.12-1935	33.89-1922	19.29-1978	30.33-1959	13.98-1911	60%	48
49		18.32-1950	34.20-1971	19.40-1948	30.34-1942	14.16-1922		49
50		18.38-1943	34.31-1932	19.54-1902	30.70-1976	14.23-1928		50
51		18.39-1947	34.41-1919	19.64-1919	30.77-1958	14.29-1904		51
52		18.42-1911	35.14-1979	19.87-1963	31.17-1929	14.43-1938		52
53		18.55-1908	35.24-1951	19.97-1900	31.43-1979	14.43-1971		53
54		18.62-1954	35.28-1950	20.63-1929	31.51-1906	14.52-1942		54
55		18.72-1957	35.39-1929	20.66-1916	31.92-1960	14.52-1946		55
56	70%	18.83-1942	35.83-1946	21.00-1968	32.01-1915	14.58-1926	70%	56
57		18.84-1970	35.92-1975	21.05-1903	32.09-1940	14.63-1907		57
58		18.91-1905	36.21-1960	21.17-1971	32.28-1974	14.70-1930		58
59		18.97-1914	36.35-1920	21.23-1901	32.68-1932	14.73-1978		59
60		18.98-1968	36.48-1928	21.36-1914	32.91-1908	14.78-1973		60
61		19.06-1900	36.56-1944	21.39-1965	32.91-1922	14.88-1920		61
62		19.24-1903	36.88-1906	21.44-1922	33.03-1903	14.92-1944		62
63		19.28-1915	37.50-1935	21.46-1941	33.20-1968	15.04-1937		63
64	80%	19.34-1964	38.09-1961	21.52-1918	33.25-1946	15.06-1929	80%	64
65		19.35-1902	38.87-1949	21.83-1953	33.39-1944	15.18-1957		65
66		19.41-1901	39.04-1926	21.98-1923	33.86-1907	15.34-1967		66
67		19.44-1921	39.37-1974	22.19-1951	33.92-1902	15.62-1925		67
68		19.52-1971	39.42-1968	22.48-1957	34.09-1949	15.88-1913		68
69		19.87-1916	39.55-1927	22.62-1908	34.24-1920	15.97-1947		69
70		19.89-1922	39.76-1905	22.74-1909	34.57-1935	16.03-1905		70
71		19.98-1953	39.98-1942	23.13-1927	35.45-1973	16.05-1918		71
72	90%	20.03-1906	40.33-1959	23.41-1920	36.05-1913	16.33-1909	90%	72
73		20.39-1912	40.54-1902	23.80-1942	36.33-1926	16.54-1945		73
74		20.79-1962	42.28-1945	24.62-1906	36.93-1957	17.15-1941		74
75		20.85-1975	44.98-1923	24.62-1946	37.88-1914	17.28-1908		75
76		21.17-1965	45.52-1915	24.64-1944	40.34-1923	17.82-1906		76
77		21.36-1977	46.50-1941	24.66-1905	40.93-1941	18.16-1927		77
78		21.51-1927	47.07-1973	24.87-1962	41.73-1905	18.40-1912		78
79		21.55-1944	47.73-1908	25.37-1977	42.17-1900	19.31-1923		79
80		23.30-1941	48.23-1957	28.61-1915	45.64-1919	19.42-1915		80

is always of great interest and speculation, causing diversity of opinions. Eighty years of annual precipitation in Nebraska were plotted on a time series graph (Figure 6) to see if cycles or trends could be detected. When plotted on an individual year basis the oscillations were frequent and large. Five year running averages dampened the oscillations considerably but still did not give a definite picture (see Figure 7). There is insufficient evidence shown on these graphs to justify using the data as a means of predicting the future in respect to either trends or periodicity. Much has been made of the recurring twenty-year cycle and these graphs do show low spots in the precipitation from time to time, but the interims are not of the same length--only approximating twenty or twenty-two years. The depth and length of these dry spells show considerable difference.

Seasonal distribution of precipitation should be of the same interest as the annual amounts. Three coldest months of the year in Nebraska are December, January, and Februrary, they constitute winter. The three hottest are June, July, and August, they are the summer season. Spring and fall are transitional months. As a rule the weather in spring is not a gradual change but rather a series of winter days and summer days interpsersed with each other. Winter days predominate in early spring, gradually giving way to more and more summer-like days as spring advances. Somewhat similar action occurs in the fall, but it is not as pronounced.

Season-wise, precipitation is least in the winter; increases in amount as spring advances; is greatest in the summer; decreases during the fall. There is an exception to the above when the precipitation is viewed on a monthly basis. May, a spring month, receives more moisture than either of the summer months of July or August, and nearly as much as June, the wettest month of the year.

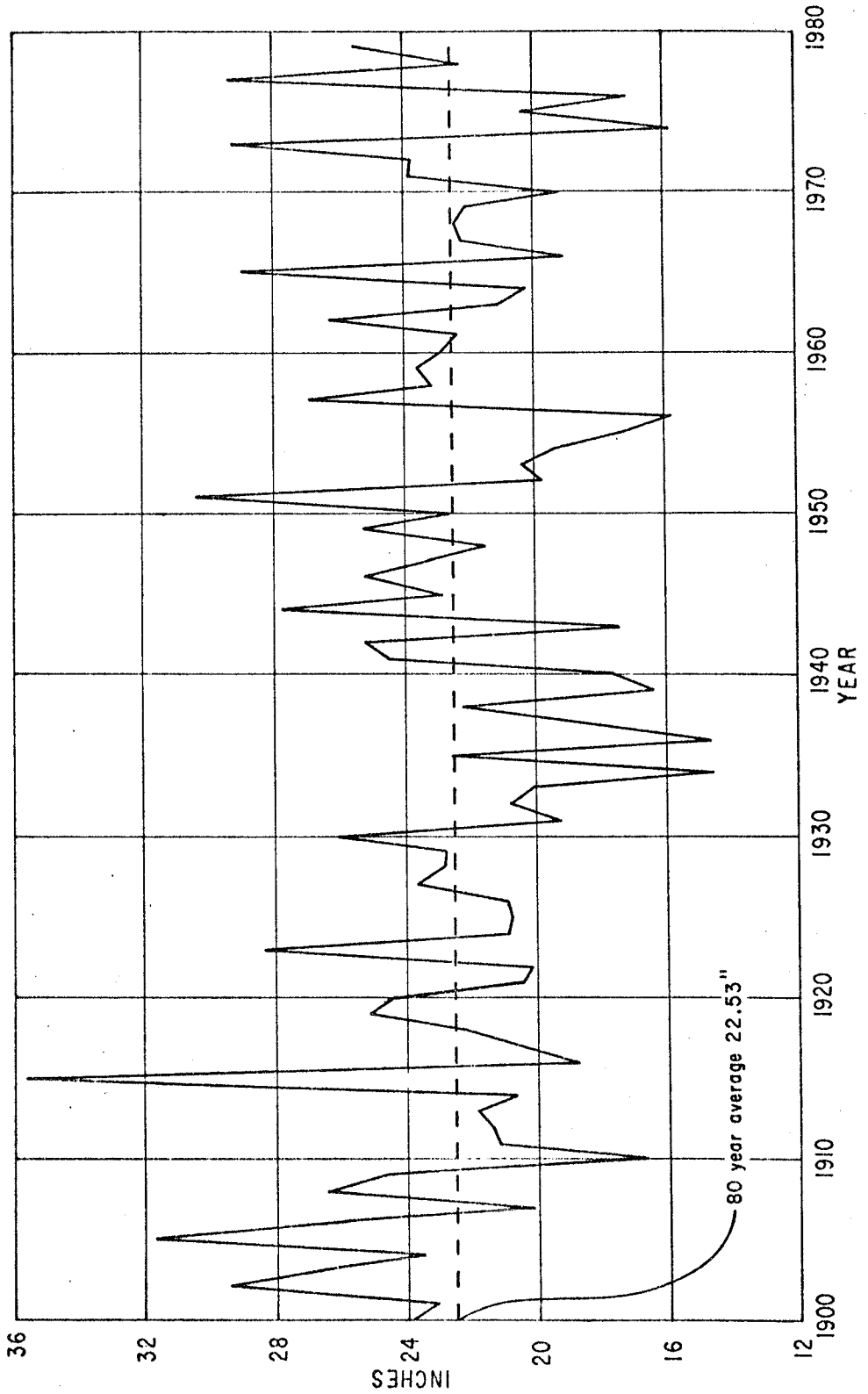


Figure 6. Annual precipitation in Nebraska, 1900-1979.

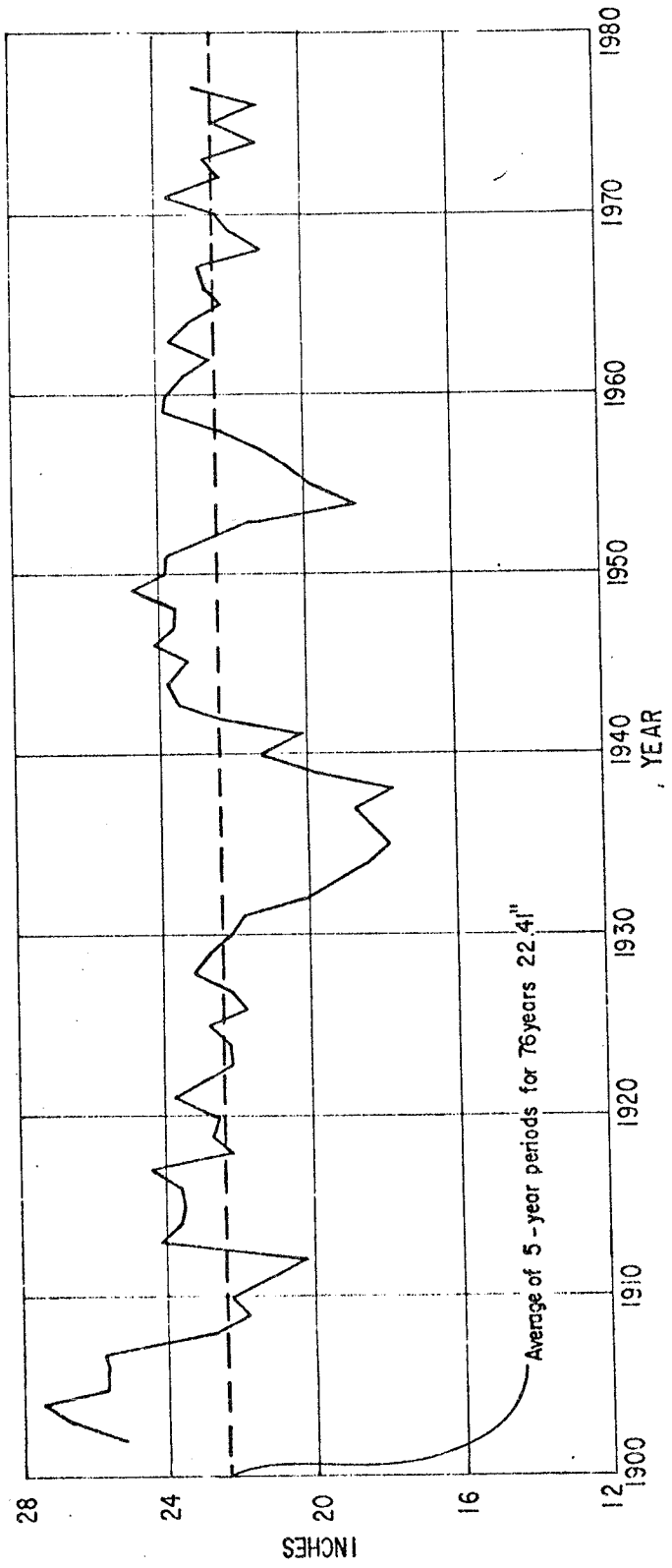


Figure 7. Five-year running average annual precipitation in Nebraska, 1902-1977.

Further comments on the nature of the precipitation in each season is in order. It has already been stated that during the summer the air becomes unstable by flowing over warm ground en route from the Gulf of Mexico. However, in the spring the ground is generally colder than the air, thus increasing its stability as it moves northward. The early spring precipitation is likely to be of the slow, steady, persistent type occurring over a rather large area and thus can be of great benefit. A considerable amount of the March precipitation is in the form of snow, or rain mixed with snow. The character of precipitation changes more and more to showers and thunderstorms as spring advances. Late spring and summer thunderstorms are often accompanied by hail, which is sometimes severe. Much has been written about the great damage that is wrought by the hail, and no doubt much damage is done. Crops receive a varying amount of damage and sometimes they are a total loss. The media will carry vivid accounts and pictures of the devastation. The point that is generally overlooked is that the same atmospheric disturbance that brought the hail was also responsible for widespread shower activity. Nearly always the hail strips are very small in respect to the total precipitation area that afternoon or night. The net results to the entire agricultural area involved is strongly positive in practically every instance. It is a case of disaster to a relative few but benefits to many.

Nearly all of the summer precipitation falls from showers and thunderstorms. More precipitation is received during summer than in any other season. The erratic nature of this type of precipitation often gives poor distribution in both time and space. Drouthy periods develop when the timing is poor. When the spacing is poor a large amount of rain may fall at a given location and a near-by site may receive little or none. Sometimes it seems that a certain site may not be getting its fair share of moisture as shower after shower passes it by. This may occur at the same site for several years in a

row, local residents begin to feel that this may be a permanent quirk of the weather. However, it is not, because records show that over a longer period the showers will pretty much even out. A differentiation should be made for the western portion of the state where the variation in topography is much greater and is large enough to have a noticeable effect. The effect there is most noticeable when east to northeast winds persist.

The showers and thunderstorms continue into the fall but gradually decrease in frequency and intensity. September, the first fall month, receives almost as much moisture as August, with the heaviest amounts generally occurring in the first half of the month. By September the rapid decrease in moisture is in effect. September receives only slightly more than half as much moisture as August. The decrease continues into October when the drier conditions are an aid to harvesting operations.

Winter precipitation is the lightest of all seasons and what does fall is nearly all in the form of snow. Freezing rain (glaze) occurs often enough in the southeastern corner of the state to be troublesome. It is often light enough to avoid extensive tree or transmission line damage, but on a few occasions widespread severe damage is done.

The winter snows may be either beneficial or detrimental. Normally the snow is not heavy enough to cause great concern. If the snow falls without wind the ground cover it leaves may be quite beneficial. A good cover of snow dampens the fluctuations that occur in the soil temperatures. The damaging snows are those that are accompanied by high winds that pile the snow into huge drifts and leave large open areas nearly bare of snow. The drifts bring most outdoor activities to a halt until they can be cleared away.

Blizzards occur when the snow is accompanied by both high winds and low temperatures. Near blizzards that cause temporary problems are not unusual, but true full sclae blizzards are infrequent. Full blown blizzards are

hazardous storms which may, and generally do, result in the loss of life to humans, livestock, and even wildlife. The dates of two of these full blown blizzards are the winters of 1888 and 1949.

Temperatures in Nebraska

Temperature changes are frequent in Nebraska. The change to lower temperatures is sometimes very sharp and may be very large. Sharp and large changes should be expected with the passage of the cold front ahead of a mass of dry Canadian or Artic air. The winds ahead of the front are generally from the south or southwest with temperatures on the warm side. As a rule the change to higher temperatures is more gradual, but in total can be quite large.

In contrast to the frequent temperature changes on a short term basis the yearly averages show little variability. The average of the eighty years (1900-1979) of annual average temperatures is 49.5° F. and they have a standard deviation of only 1.4° F. (see Figure 8). The annual temperature fell between 47.8° and 51.6° F. in 80% of the years. The extreme annual temperatures were 46.8° F. in 1978, and 53.3° F. in 1934.

Seasonal temperatures should be of more interest than the annual averages. Winter daytime temperatures average in the middle 30s to the low 40s; nighttime readings average about 10 to 15 degrees. January is the coldest of the three winter months. The average winter (Dec-Jan-Feb) temperature for the eighty years is 25.7° F. with a standard deviation of 3.2° F., this is higher than that for the entire year. The extremes are also greater. The coldest winter this century was in 1979 (Dec. 1978-Feb. 1979) with an average temperature of 15.3° F. The warmest winter was 31.5° F. in 1934.

Temperatures can drop very low under some conditions. A good example is at a time when a fresh Canadian or Artic air mass lies over the state with light winds and perhaps clear skies. Most places in Nebraska have reported

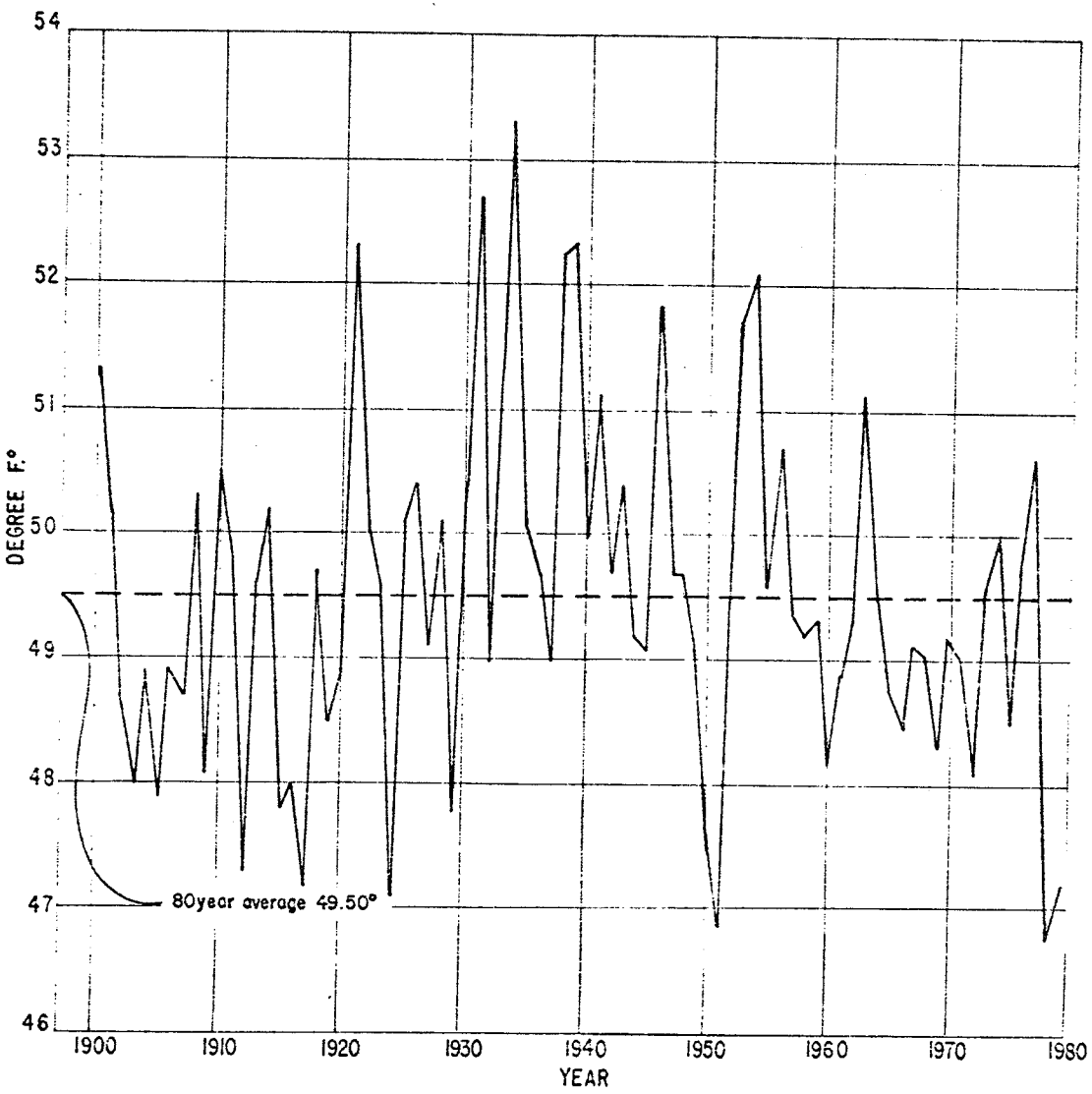


Figure 8. Annual average temperature in Nebraska, 1900-1979.

readings of thirty degrees below zero or colder and some have dropped below minus forty degrees Fahrenheit. Temperatures this low are not frequent in Nebraska, but they are a part of the climate and should be expected again sometime.

Freezing temperatures occur across the state on all but a few nights in December and January, and over most of the state in February. The southern portion averages 3 to 4 nights above freezing in February. Temperatures of zero or below occurs on an average of 2 to 4 nights in December, 5 to 8 nights in January, and from 2 to 4 nights in the south to 4 to 6 nights in the north during February. The temperature stays below freezing all day about 20 to 30 times in the south during the winter ranging up to 50 days in the north. At the other extreme daytime temperatures in the 70s and 80s have been reported during the winter months under the influence of a warm air invasion.

Spring is generally not a season of gradual warming, but rather it consists of a mixture of winter days interspersed with summer type days. There is an occasional day of what is envisioned as a typical spring day. Winter days dominate the early spring, but gradually more and more summer-like days appear as spring advances.

The average temperature for spring is 48.3° F. with a standard deviation of 2.08° F. Average high temperatures for the day rise from the upper 40s in March to the lower 70s in May. Nighttime lows increase from the low 20s in March to the upper 40s and low 50s in May.

The average date of the last 32° F. reading ranges from late April in the southeast to early May in central Nebraska and to mid-to-late May in the northwest.

Summer daytime highs average in the low 80s in June, in the upper 80s to about 90 in July and August. Nighttime lows average in the 50s in the north

and west in June and August to the low 60s elsewhere. July has averages in the low to middle 60s across the state.

The average summer temperature for 80 years is 72.7° F. with a standard deviation of 2.07° F. The hottest summer during this century was in 1936 with an average of 78.4° F.; the coldest was in 1915 with 66.9° F.

Temperatures above 90° F. occur on an average of about 35 to 40 days during the year in the north to 50 to 60 days in the south. The highest number of days in excess of 90° F. occur along the Kansas-Nebraska border in the western portion of the state, where 60 to 65 such days are reported. These do not all occur in the summer months. September has 3 to 5 days in the north and 7 to 9 days in the south; an occasional 90° appears in October. Some pre-summer 90° days are also noted. Isolated 90° days have been reported in March and April; May has an average of from 1 to 3 days with 90° F.

Temperatures climb above 100° F. at most places in most years, but there are occasional years when some places fail to reach 100° F. all year. Extreme highs have been above 105° F. in all sections of the state and most stations have reached 110° F. sometime during their period of record, but those who have exceeded 115° F. constitute a small minority. The highest reading reported this century is 118° F. at Minden in the southcentral portion of the state and at Hartington in the northeast. Both readings were made in July 1936.

Most years the fall weather is delightful. Temperatures averaged 51.4° F. with a standard deviation of 1.8° F. over the past 80 years. Fall had the smallest standard deviation of all seasons. The coldest fall occurred in 1949 with an average temperature of 47.4° F.; the warmest was 56.2° F. in 1963.

There is a decrease in cloudiness at this time of the year with many bright days and nights; temperatures are falling into a comfortable range. Daytime highs average about 75 to 80 degrees across the state in September falling to about fifty in November. The nighttime lows range from the middle

forties to middle fifties in September, dropping into the twenties for November. There are a few hot days early in the fall, as noted above, and some cold ones late in the season. October has a rare day now and then when the temperature remains below freezing all day and there are an average of 2 to 4 such days in November.

Freezing temperatures are few in number in September, occurring mostly in the west, but October generally has a number of freezes and November averages over 20 nights below 32° F. The average date of the first 32° F. reading in the fall ranges from September 15th to the 25th in the west and western sandhills to September 30th to October 10th at most other sites.

Miscellaneous Weather Elements

Wind

The surface wind speed averages about 10 MPH. Speeds of less than 3 to 4 MPH occur about 14% of the time, and those over 20 MPH about 9% of the time.

High winds are of two types. One associated with a deep low pressure center passing nearby may last over a large area for a number of hours or on some occasions for a full day or two. On rare occasions this type of wind might do some damage, generally in the nature of blowing roofs off or pushing in plate glass windows. The second type are those due to atmospheric instability and are generally associated with thunderstorms and are of short duration. They are the fastest of all the winds in Nebraska, excluding tornadoes. They are often strong enough to do severe damage in a restricted area, but should not be confused with tornadoes. Tornadoes are also associated with thunderstorm activity, but are different from the erratic blasts of air emanating outward from the storm. A recent study indicates that any given spot in Nebraska should anticipate a wind speed (at 30 feet) lasting nearly a minute in the range of 76 to 84 MPH, and with the highest gust reaching about 100 MPH on an average of once in 50 years.

Wind directions are also variable in Nebraska, with the wind shifting directions at frequent intervals. Winds blow from a southerly quadrant more than half the time from May through September and from a northerly quadrant much of the time the rest of the year.

Nebraska averages about 12 tornadoes per year, occurring mostly in May, June, and July. There are many more in the eastern portion of the state than in the west.

Cloudiness-Sunshine-Radiation

Cloudiness, sunshine, and solar radiation are inter-related. Latitude is a strong factor in the latter two. Cloudiness has been well documented since the advent of aviation; sunshine and solar radiation less so. Four National Weather Service stations are recording sunshine data in Nebraska at the present time. One National Weather Service station is making solar radiation readings and in addition some measurements are made as needed in connection with research projects by other agencies. Because the relationships between these elements has been rather well established it is sometimes advantageous to use the data available to estimate solar radiation values. However, the data on hand here is insufficient to attempt to determine the frequency distribution of solar radiation amounts in Nebraska. More complete solar radiation data is available from the Environmental Data & Information Service, National Climatic Center, Asheville, North Carolina 28801.

Fifty to eighty years of sunshine data are available at the four sites in Nebraska. Sunshine measurements are stated in the percentage received at the earth's surface in relation to the total amount that would be possible if there was no interference. The possible amount does not vary from year-to-year, but the part that is blocked by clouds, fog, etc. does vary and this causes the amounts that reach the earth to vary also. The variation is not very large when considered on an annual basis, but increases considerably when shorter time periods are used. The amount also varies with the season from an average of about 55% in December to nearly 80% in July. It varies somewhat with

location in the state. The annual average percentage of possible sunshine at North Platte and Valentine is 67%, at Lincoln 63% and at Omaha 62%. Evidently there is less interference with the sunshine in the central portion of the state than in the east. Based on the fifty to eighty years of record available the year-to-year distribution is as follows:

Percentage of Possible Sunshine

	Omaha	Lincoln	North Platte	Valentine
Least year	52%	54%	53%	56%
20% of years = or less than	59%	60%	63%	63%
50% of years = or less than	62%	62%	68%	68%
80% of years = or less than	66%	68%	70%	71%
Highest year	73%	73%	73%	76%

Heating and Cooling Degree Days

The 1941-1970 normal number of heating degree days for Nebraska is between 6,000 and 7,000. The range is from a little below 6,000 along the southern border in the eastern portion of the state to a little more than 7,000 in the northwestern corner.

Heating degree days have not been computed on a state-wide basis but some idea can be had about the season to season distribution by looking at the records from som individual sites over the past eighty seasons.

Heating Degree Days

	Lincoln	North Platte	Valentine
Warmest season	5159	5185	6040
20% of seasons equal to or less than	5640	6152	6844
50% of seasons equal to or less than	5927	6572	7242
80% of seasons equal to or less than	6296	6912	7604
Coldest season	7078	7989	8622

The normal (1941-1970) average summer temperature is 75.2° in the southeastern division and 70.0° in the Panhandle. This difference in temperature is reflected strongly in the normal number of cooling degree days. The normal number of cooling degree days of 1200-1300 in the southeast is approximately double the normal of 600-700 per season in the Panhandle.

Conclusions

A study of the various elements that together comprise the climate of Nebraska leads to the conclusion that they are typical of the elements that make up the climate of regions that lie in the middle latitudes and near the center of a large continent. The climate of Nebraska, particularly the western portion, is modified by the presence of the Rocky Mountains immediately to the west.

The source regions for the principal air masses entering Nebraska are: Interior Canada and the Artic region for cold dry air; the Gulf of Mexico, and Caribbean region for warm moist air; the northern Pacific Ocean for cool moist air that loses much of its moisture en route to Nebraska; and on some occasions, the desert southwest for hot dry air.

The interplay of these air masses plus local heating and cooling effects accounts for the climate of Nebraska including its many variations. Pressure patterns around the world and the resulting upper air flow influence the movement of the air masses. At times persistent patterns result in the dominance of the weather over Nebraska by air from a particular source region; this leads to the spells of weather that depart from the long term averages.

The summer to winter reversal of the relative temperatures of the water in the Gulf of Mexico and Caribbean areas and those of the land mass north of Nebraska are partially responsible for the southerly surface winds in summer and the northerly ones in winter. This in turn has much to do with the nature and amount of the seasonal precipitation.

The constancy of this temperature relationship and also that of the source regions leads one to believe that barring unforeseen drastic changes in the

transmissivity of the atmosphere or other effects of human tampering with it we should not expect any rapid change in Nebraska's climate on a permanent basis. However, we should look forward to a continuation of the oscillating, back-and-forth nature of our climate to continue into the future, the same as it has in the past.

Climatological data presented herewith for the 1900-1979 period documents these wet-dry and warm-cold periods. It also shows that for short time periods and/or small areas the changes can be both sharp and large, but for the state as a whole and for longer periods the elements are less variable.

The wet-dry spells are more pronounced than the warm-cold spells. The extremes in the 5-year precipitation averages for Nebraska range from a low of 17.71 inches (1936-1940) to a high of 27.25 inches (1902-1906). The 17.71 inches is only 21% below the average 80-year precipitation. This points out how drastic effects of a small persistent drop in precipitation amounts can be.

The extreme range in 5-year average temperatures is only 3.1° F. Neither the hottest 5-year period nor the coldest one departed as much as 2° F. from the long-term average. If there was a permanent change of only a few degrees the change in the overall climate would be large because of a chain reaction.

Short term periods are different. The weather can be very dry, very wet, very hot, and/or very cold for short periods, without imparting lasting results. These extreme days or relatively short periods are the ones that attract so much attention but many times the results are soon lost when the weather changes again. However, these short periods can bring disastrous results when they persist a bit longer than usual. These kinds of gyrations are a part of the climate and must be anticipated from time-to-time although during most of the time weather conditions remain close to the long-term averages.

The 1975-1979 average temperature of 48.6° is only 0.4° F. above the coldest 5-year period, 1978 was the single coldest year of this century followed by the coldest winter. These facts taken alone might lead one to believe Nebraska is getting colder, but the oscillations on the time-series chart of temperatures indicate that this spell will come to an end also and we will return to warmer conditions.

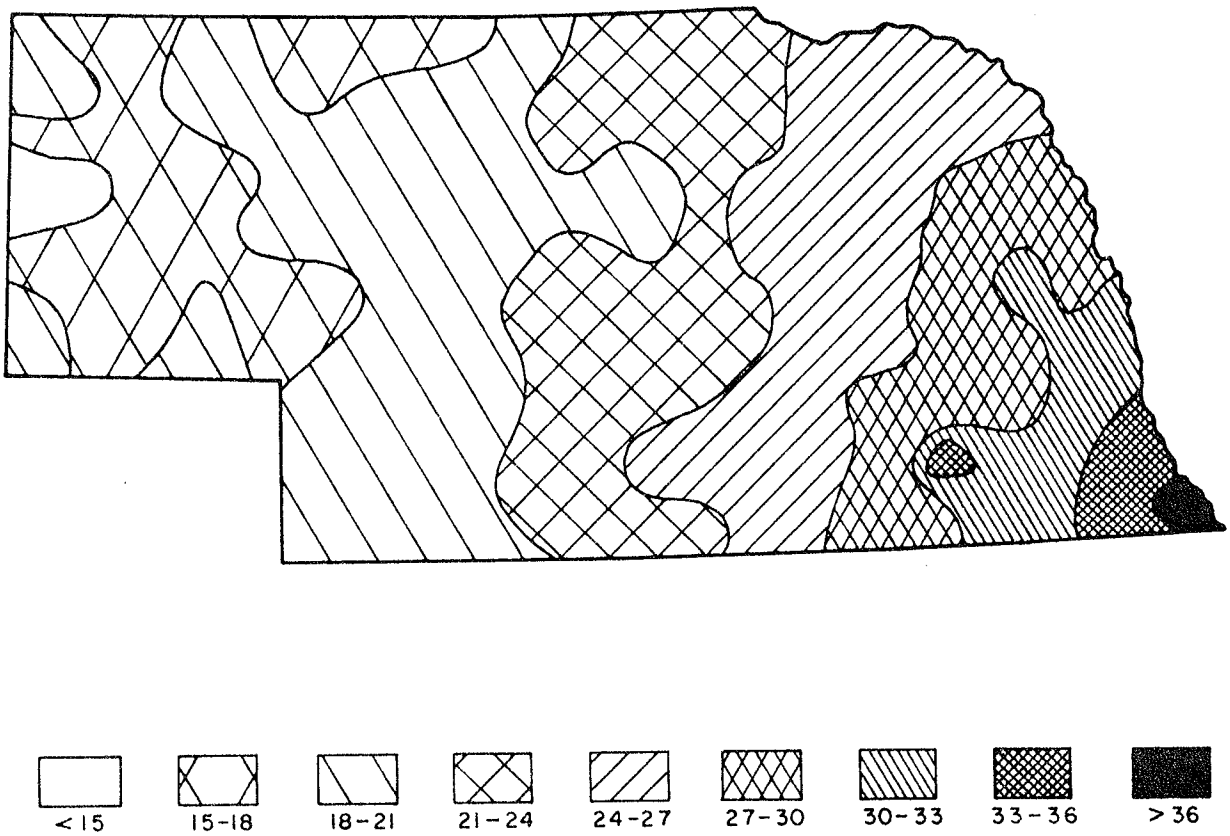
The sparcity of weather observations and differing methods of measuring the weather elements in Nebraska during the 19th century raises the question of homogeneity of the records prior to and after the turn of the century. Therefore, the numerical results of the 19th century observations were not used in determining the frequency distribution of the various elements. However, there is no doubt that oscillating weather spells occurred in that period also. Tree ring studies show the recurrence of drought at irregular intervals for two or three centuries before that.

The conclusion has been reached that until a breakthrough in long-range forecasting has been realized it would be better to consider that oscillating periods in the precipitation and temperature will continue to occur and to plan accordingly. Hopefully, the percentage of times the various spells occur will also remain about the same. The variation in the timing and severity of these spells has been great enough to make them nearly worthless as a forecasting tool for a given year.

Climatological data does not indicate that the long-term supply of water from precipitation is undergoing much change. The developing shortage of water appears to be due to increased usage. Evidence exists that we are using up water that accumulated under climatic conditions similar to those we now have, but when more of the precipitation found its way into the ground.

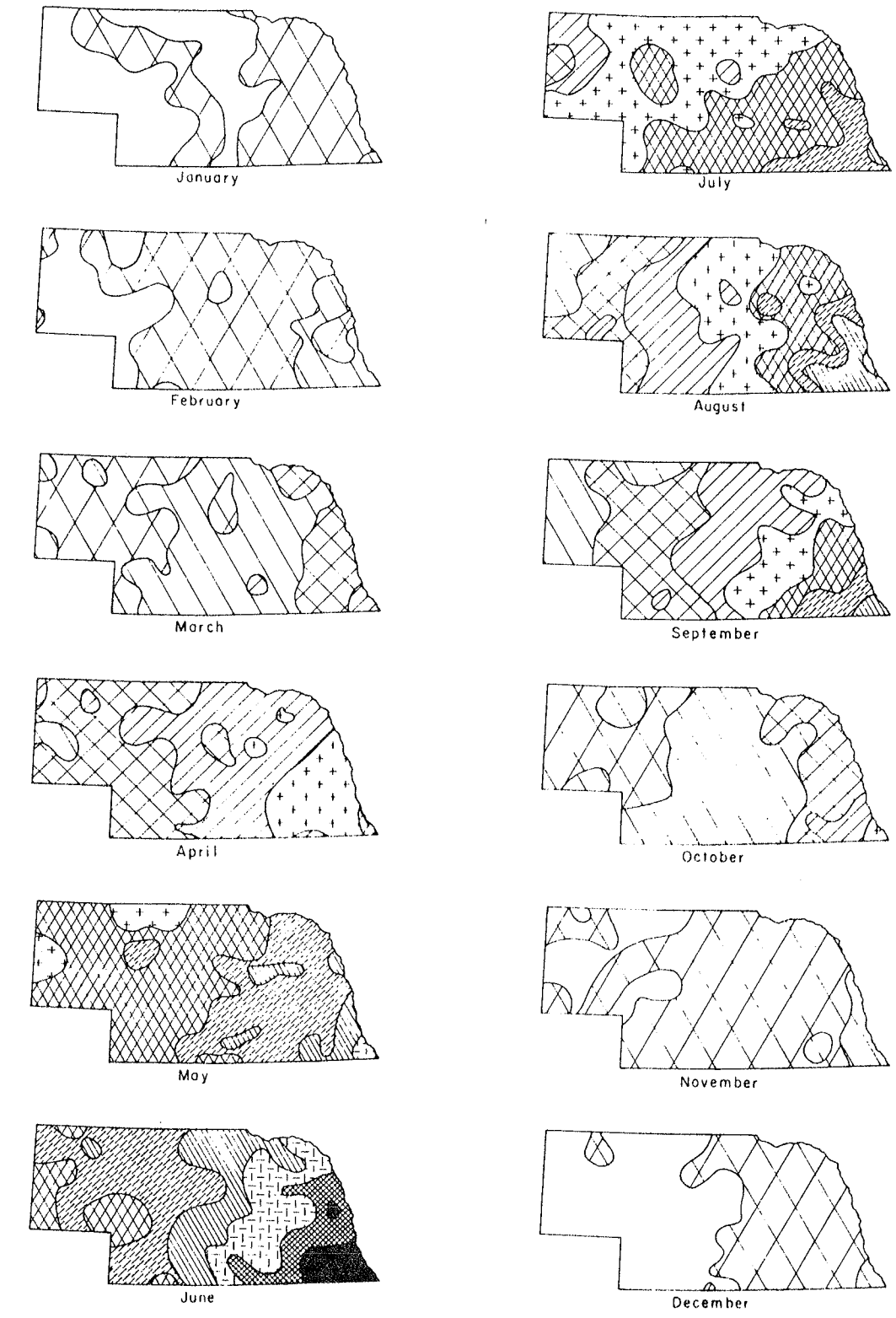
Appendix A

Graphic Display of Selected Aspects of Nebraska's Climate



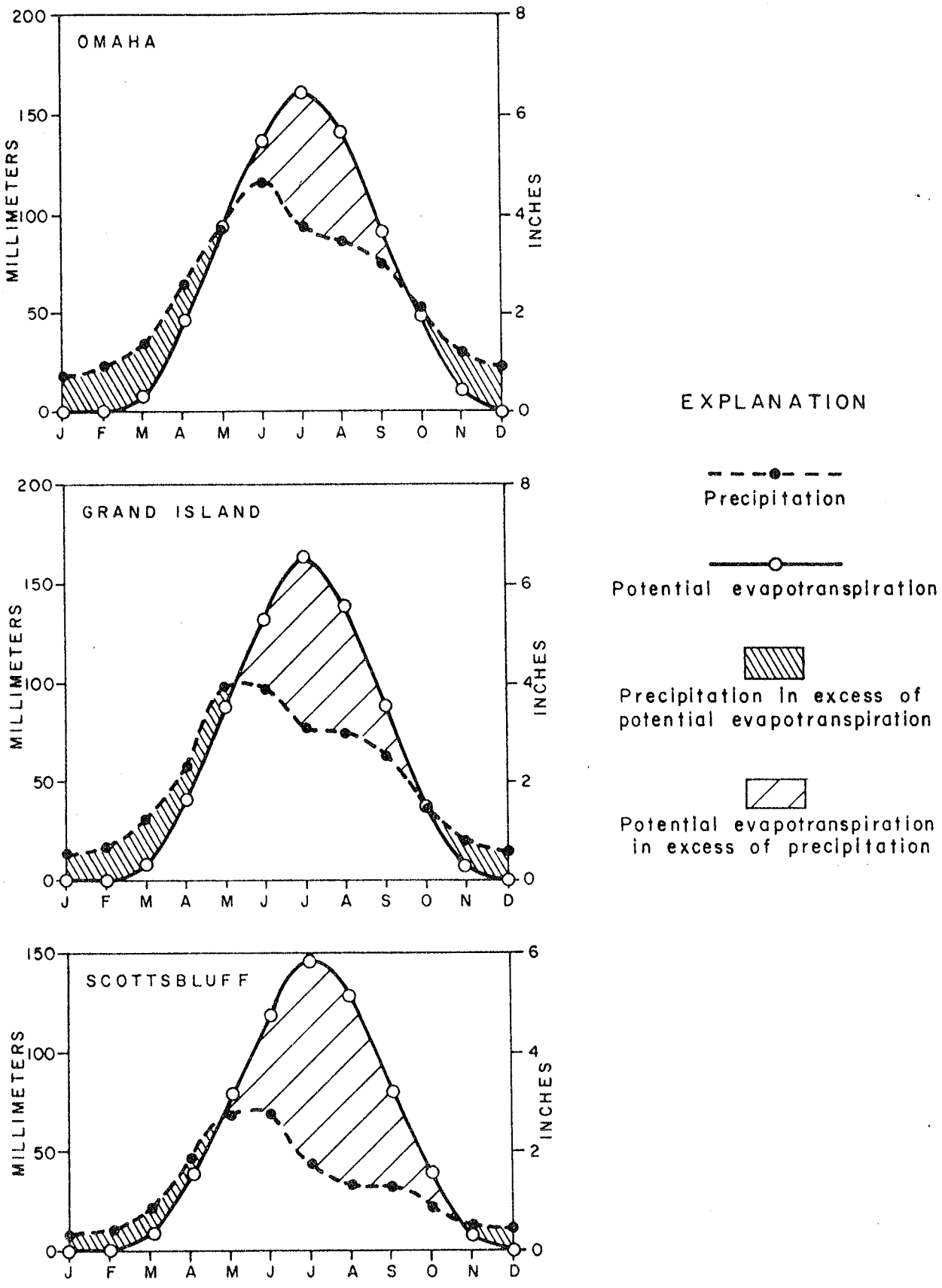
NEBRASKA'S AVERAGE ANNUAL PRECIPITATION, IN INCHES, 1941-1970

Credit: Climatic Atlas of Nebraska by M.P. Lawson, K. F. Dewey, and R.E. Neild
1977



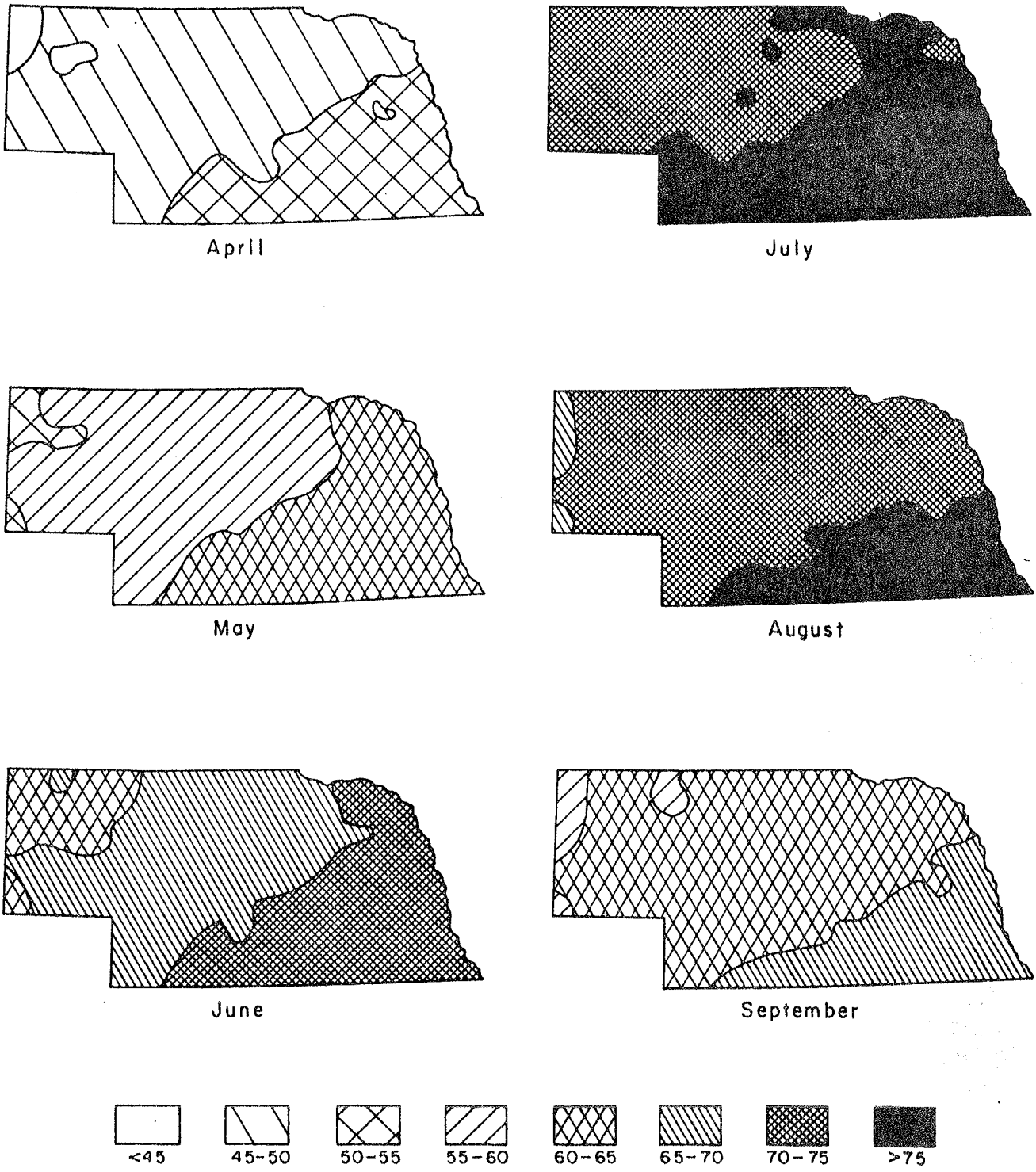
NEBRASKA'S AVERAGE MONTHLY PRECIPITATION, IN INCHES, 1941–1970

Credit Climatic Atlas of Nebraska by M.P. Lawson, K.F. Dewey, and R.E. Neild 1977



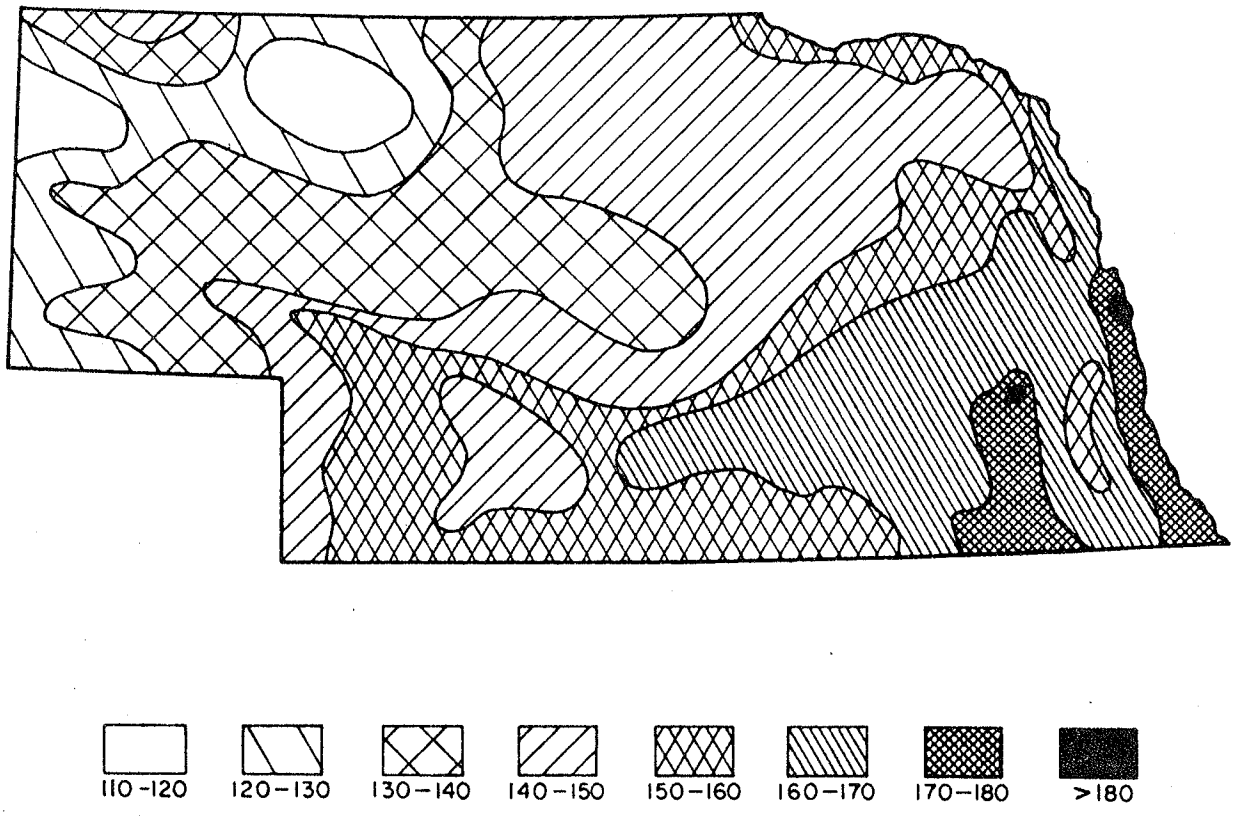
NEBRASKA'S MONTHLY PRECIPITATION AND POTENTIAL EVAPOTRANSPIRATION

Credit: Climatic Atlas of Nebraska by M. P. Lawson, K. F. Dewey, and R. E. Neild 1977



NEBRASKA'S AVERAGE MONTHLY TEMPERATURES DURING GROWING SEASON IN DEGREES FAHRENHEIT

Credit: Climatic Atlas of Nebraska by M.P. Lawson, K.F. Dewey, and R.E. Nelld 1977



NEBRASKA'S FREEZE-FREE SEASON, AVERAGE LENGTH IN DAYS

Credit: Climatic Atlas of Nebraska by M.P. Lawson, K. F. Dewey, and R.E. Neild
1977